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Description of the Edison Steam Dynamo.

BY T. A. EDISON, PH. D., AND CHARLES T. PORTER.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The central Edison station of the first district in New York City will, when fully equipped, be supplied with twelve dynamos, each of which is nominally rated as a 1200-light machine, at 16 candle-power incandescence, but is capable of supplying 1400 lights of this power, continuously, and with high economy, without heating the armature, or burning or injuring the commutator or brushes. This increased capacity is due to improvements in the lamp itself.

The armature of each dynamo is driven by a Porter-Allen engine, of $11\frac{3}{16}$″ diameter of cylinder by 16″ stroke, directly connected, and making 350 revolutions per minute giving a piston travel of 933 feet per minute.

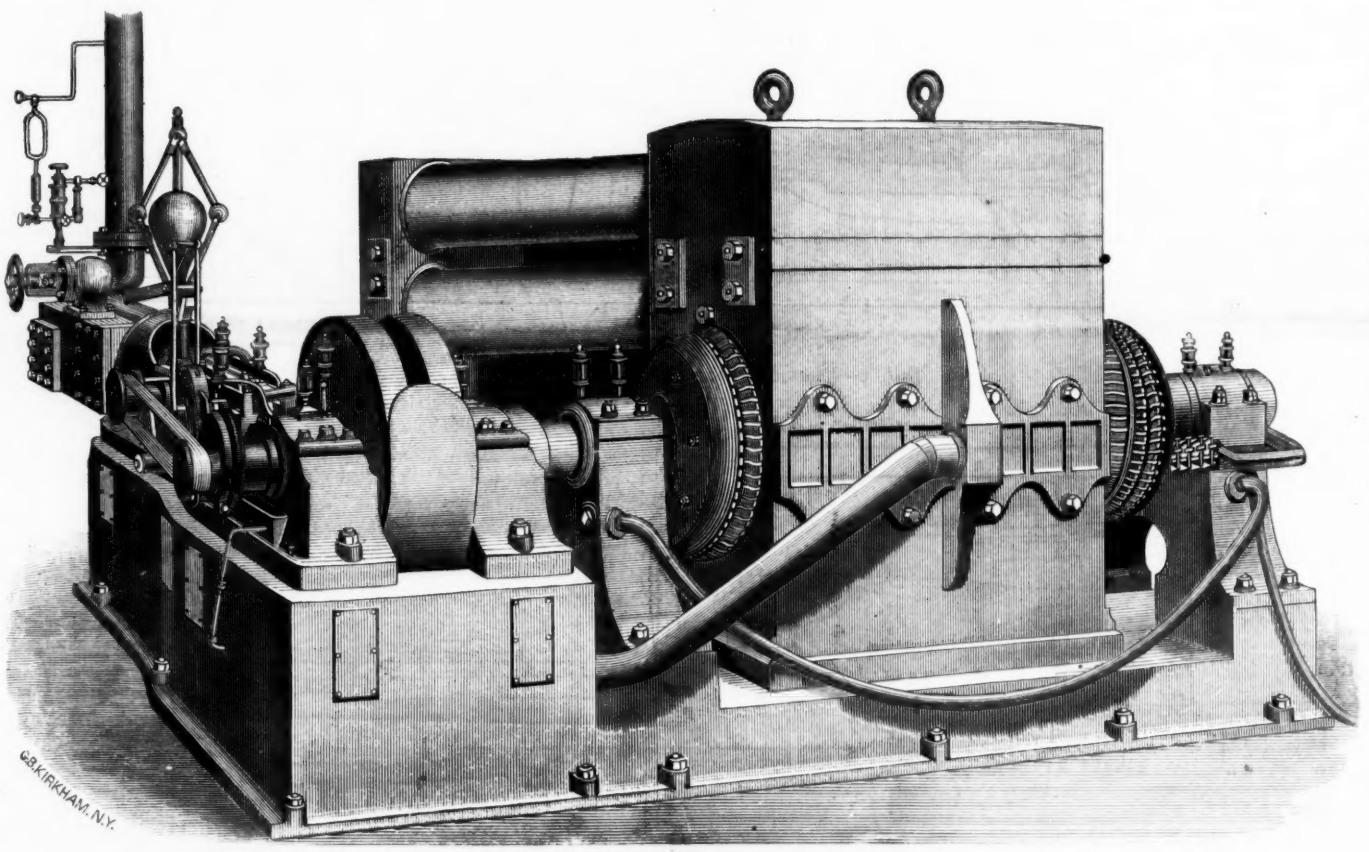
The steam is supplied by eight Babcock & Wilcox boilers of 2,000 aggregate horse power, and which will work under a pressure of about 120 pounds. These occupy the basement of the building. Over them, the first and second floors being removed, an iron superstructure is erected entirely separated from the walls of the building, and on this the combined dynamos and engines are placed.

One-half of this equipment is now nearly ready for service, and the remainder is expected to be completed during the coming season.

The armature of the dynamo is of the form commonly known as the Siemens armature, but in its construction and "connecting up" it differs radically from all others.

The foundation of the armature, or the iron core which is built upon the shaft, is made up of sheet iron discs, separated from each other by sheets of tissue paper, and bolted together. This has all the advantages of a solid iron core in strengthening the magnetic field, while it completely prevents the great loss of power by local currents, which would circulate in the iron if it were solid. In the place of insulated wires, the cylindrical face of the armature is made up of heavy copper bars, trapezoidal in section, each bar being insulated, and also separated from its neighbors and from the iron core underneath by an air space.

The connection between the bars on opposite sides of the armature, to form the electrical circuit, is made by copper discs, of the same diameter as the core. At each end of the core are one-half as many of these copper discs as there are bars, each disc being insulated from its neighbors, and the whole being bolted together in such a manner as to form, with the discs of sheet iron constituting the core, one solid mass. Each disc is formed with projecting lugs on its opposite sides to which the two bars are connected.



STEAM DYNAMO (DYNAMO AND ENGINE COMBINED).

The connections between the opposite surfaces of an armature are of no benefit in generating an electric current, but are a necessary evil, introducing useless resistance into the circuit. By using for this connection copper discs in the manner described, a great weight of copper is disposed in a limited space; and so this useless resistance, and consequent loss of energy, is reduced to a minimum.

This method, moreover, reduces the work to a simple machine construction, in which all the parts are duplicates, and the operations can be much cheapened and facilitated by the use of special tools.

The spaces between the armature bars admit of a free circulation of air, thereby preventing the accumulation of heat, and increasing to an enormous degree the capacity of the machine. The armature is at intervals wound with piano wire over the bars to resist the centrifugal force developed by their revolution.

The commutator and brushes of an electrical machine are the parts subject to the greatest depreciation. In this machine all parts of the end of the armature are so constructed as to be easy of access, and they can be quickly and cheaply repaired, or removed and replaced by new parts, when necessary. Any accident would require but a short stoppage for repairs.

Provision is made for keeping a continuous and rapid circulation of air over the entire face of the armature.

This armature is 27.8″ in diameter by 61″ long. The commutator adds 18″ to this length, and is itself $12\frac{3}{4}$″ in diameter. The armature shaft is of steel, $7\frac{3}{4}$″ in diameter, having a total length of 10′3″. The journals are $6\frac{1}{2}$″ in diameter by 15″ long, and run in babbitt-metal bearings in pillow blocks of the box form, giving the greatest stiffness with minimum of weight.

Provision is made for continuous water circulation underneath the boxes, and for continuous lubrication, with traps to prevent the creeping of the oil along the shaft and reaching the commutator, and drains to receive it as it runs through the bearings and convey it to a drip pan.

The magnet is made up of two immense cast iron "pole pieces," between the semi-cylindrical faces of which the armature revolves, twelve cylindrical soft iron cores attached to these pole pieces, and made magnetic by an electrical current circulated in the wire wound around them, and four soft iron keepers connecting the back ends of these cores. Eight of the cores are attached to the upper pole piece, and four to the lower one.

The width of these "poles" is 49″, and their height $61\frac{1}{2}$″. The length of the twelve soft iron cores is 57″, the diameter of the eight upper ones is 8″, and of the four lower ones 9″.

The four soft iron keepers are each 11″ wide by 9″ in thickness, and the total length of the magnet is 94″.

The magnet is insulated by cast zinc bases 3″ in thickness.

The weight of the dynamo is as follows:

Armature and shaft	9,800 lbs.
Two pillow blocks	1,340 lbs.
Magnet, complete	33,000 lbs.
Zinc bases	680 lbs.
Total	44,820 lbs.

The copper is distributed as follows:

In the armature bars	590 lbs.
" " discs	1,350 lbs.
In the magnet wire	1,500 lbs.
Total	3,440 lbs.

Mr. Edison was early impressed with the conviction that to give steady and reliable motion to these armatures it would be necessary to connect an engine to each one of them directly. This combination has been termed by him the Steam Dynamo.

In adapting the Porter-Allen engine to this service a special construction in some respects was found to be called for. These special features will be briefly described.

It seemed important to avoid a rigid connection between the engine and the armature shafts, which would require the entire series of bearings to be maintained absolutely in line. In place of this, therefore, a self-adjusting coupling [see Fig 5, page 3] has been introduced, which will permit of considerable errors of alignment without any abnormal friction being produced in the bearings.*

The point of difficulty was the backlash, the engine having no fly-wheel, except the heavy armature itself, which was to be driven through the coupling. Provision was made for taking this up by steel keys of a somewhat peculiar form, between which the tongues of the coupling move freely, while they themselves are immovable. These keys are held between set-screws threaded in wrought iron rings covering the flanges on the ends of the shaft. All the faces liable to move upon each other are oiled from a central reservoir. This coupling is a very compact affair, without a projection anywhere above its surface, and gives every promise of completely answering its purpose.

The engine is made with a forked bed and two shaft bearings and a double crank, and

* This coupling is the same in principle as the Oldham coupling shown in the AMERICAN MACHINIST, Aug. 27, 1881.

so is completely self-contained. It is shown in plan and elevation, Figs. 1 and 2.

The shaft having no support beyond these bearings on either side, unusual stiffness was required in the crank pin to prevent deflection under the great strains to which it is subjected.

A novel form of pin (see Fig. 3) was proposed by Mr. Richards, which is found to possess all the rigidity required. It is provided with flanges which are let into each crank, and held each by four screws, as shown, while the shanks of the pin are also forced firmly into the cranks.

Special appliances enabled the work of putting the cranks together in this manner to be done with extreme and uniform accuracy.

The engine is so arranged as to have the valve gear on the side furthest from the dynamo. The engineer has not to go between the engine and the dynamo, when running, for any purpose.

The connecting rod (Fig. 4) is of steel, and the crank-pin boxes are formed directly in the end of it.

This end is finished from a solid forging, and chambered out for babbitt metal. The bolts are then fitted, after which it is parted and holes are drilled for holding the babbitt securely.

In the connecting rods for single crank engines of this type permanent length of rod is secured by forming the crank pin end solid, and taking up the wear by a wedge closing up the inside box. In these double crank engines this construction is impracticable, but the same object is attained by forming the cross head end in the manner shown, in which the strap is made permanent, and the inside box is closed up by a key bearing against a steel plate.

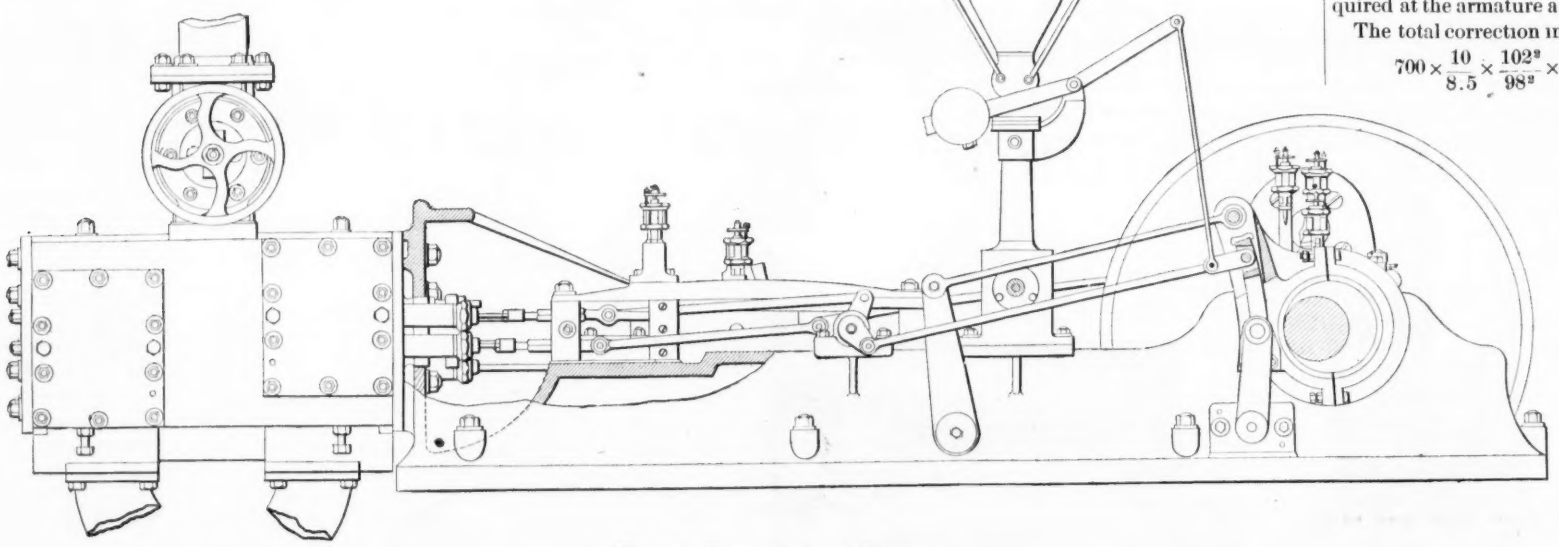


FIG. 2—ELEVATION OF ENGINE.

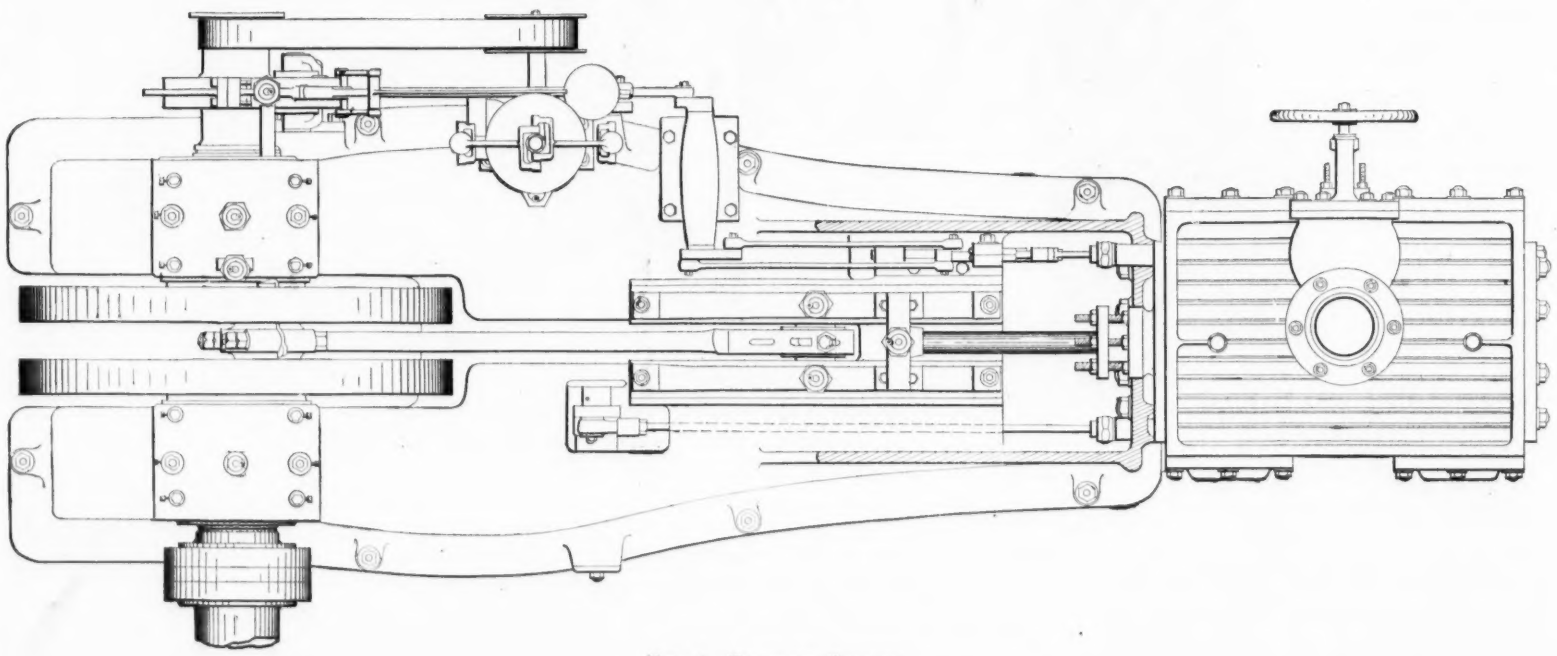


FIG. 1—PLAN OF ENGINE.

The weight of the reciprocating parts of this engine is as follows:

Piston, with rod	83 lbs.
Cross head	42 "
Connecting rod	109 "
Total	234 lbs.

The initial acceleration of this mass, or the force required, on the dead centers, to give it the motion necessary to relieve the crank from strain is as follows:

$$350^2 \times .66 \times .000341 = 27.57,$$

or 27.57 times the weight of the mass, which gives

$$234 \times 27.57 = 6451 \text{ lbs.}$$

The formula is $R^2\ l\ c$, when

R=the revolutions per minute;

l=the length of the crank in decimals of a foot; and

c=the coefficient of centrifugal force.

The connecting rod is 48″, or 6 cranks, in length. This affects the initial acceleration, making this to be on the dead center farthest from the crank 7526 lbs., and on the dead center nearest to the crank 5376 lbs., a difference of 40 per cent.

The area of the cylinder is 98.2 square inches.

The area of the piston rod, $1\frac{3}{4}$ inches diameter, is 2.4 square inches, leaving area of cylinder at crank end 95.8 square inches.

The initial accelerating forces are therefore as follows, viz.: at the end of the cylinder farthest from the crank 77 lbs., and at the end of the cylinder nearest to the crank 56 lbs., on the square inch of piston area.

The counterweight was after some trials fixed at 135 lbs. This leaves 99 lbs. of the reciprocating parts running unbalanced. It is found that this is not sufficient to disturb the stability of the engine, while on the other hand the counterweight is not so great as to exert an objectionable strain in the vertical direction.

The total weight of the engine is 6,445 lbs.

The engine and dynamo are mounted on a cast-iron base plate, made for convenience in two parts, and bolted together.

The dimensions of this base plate are as follows: length 14 feet, width 8 feet 9 inches; and its weight is 10,300 lbs. The entire weight is therefore as follows:

Base plate	10,300 lbs.
Dynamo,	44,800 "
Engine,	6,450 "
Total	61,550 lbs.

The large engraving is a perspective view of the Dynamo and Engine combined.

The last and most careful test of one of these dynamos gives the following results, as shown by the indicator diagrams, which are here reproduced full size; scale 80 lbs. to the inch.

The lamps used in all the trials were of the older construction, of which $8\frac{1}{2}$ lamps, at 16 candle-power incandescence, require one horse power of electrical energy.

Since these were placed for experimental uses, improvements in the lamp have increased their economy, so that one horse power is sufficient to maintain fully 10 of the present lamps at 16 candle power incandescence.

Diagram No. 1 shows the friction of engine and dynamo at 350 revolutions per minute, requiring..... 13.63 H.P.

Diagram No. 2 shows the resistance with the magnet circuit on = ... 19.17 H.P.

Field 5.78 ohms, 103 volts.

The increased resistance due to the magnets was..... ..... 5.54 H.P.

Of this, the calculated energy developed in the magnets was

$$\frac{103^2 \times 44.3}{5.78 \times 33{,}000} = \text{.....} \quad 2.46 \text{ H.P.}$$

Leaving energy to be accounted for by local currents in iron core of armature, and in armature bars. 3.08 H.P.

Diagram No. 3 shows the work done in maintaining 300 lamps.

These, in the ratio of $8\frac{1}{2}$ to 10, were equal to 353 lamps of the present construction. The pressure was maintained also at 102 volts, representing 25 candle power, in place of 98 volts, representing 16 candle power incandescence, which requires the number of lamps to be increased in the ratio of 102^2 to 98^2, or to 382 lamps.

The pressure of the armature was 104 volts, showing a loss in the conductor of 2 volts, which would increase the number of lamps as 104 : 102.*

The total correction is therefore as follows:

$$300 \times \frac{10}{8.5} \times \frac{102^2}{98^2} \times \frac{104}{102} = 389 \text{ lamps.}$$

The power exerted was..... 60.6 H.P.

which gives to the indicated horse power

$$389 \div 60.6 = 6.42 \text{ lamps.}$$

The magnet circuit had now a resistance of 5.28 ohms with 104 volts pressure, representing

$$\frac{104^2 \times 44.3}{5.28 \times 33{,}000} = \text{.....} \quad 2.75 \text{ H.P.}$$

Substituting this in place of 2.46 H.P. in the first trial, we have 19.46 H.P., which, deducted from 60.6 H.P., leaves net 41.14 H.P.

This gives $389 \div 41.14 = 9.45$ lamps per H.P.

Diagram No. 4 shows the work done in maintaining 700 lamps.

The pressure of the lamps was maintained, as in the preceding trial, at 102 volts, which required at the armature a pressure of 105 volts.

The total correction in this case is therefore

$$700 \times \frac{10}{8.5} \times \frac{102^2}{98^2} \times \frac{105}{102} = 919 \text{ lamps.}$$

The power exerted was 115.83 HP. giving to the indicated horse power $919 \div 115.83 = 7.93$ lamps.

The resistance of the magnet circuit was now 4.78 ohms, with 105 volts pressure, representing,

$$\frac{105^2 \times 44\ 3}{4.78 \times 33{,}000} =$$

3 1 H.P.

Substituting this in place of 2.46 H.P. in the first trial, we have 19.81, which, deducted from 115.83 H.P. leaves net 96.02 H.P.

This gives $919 \div 96.02 = 9.57$ lamps per H.P.

Diagram No. 5 shows the work done in maintaining 1050 lamps.

The pressure at the lamps was maintained in this trial at only 99 volts, but this required at the armature a pressure of 108 volts, showing a loss of 9 volts in conduction.

The total correction in this case is thus

$$1050 \times \frac{10}{8.5} \times \frac{99^2}{98^2} \times \frac{108}{99} = 1375 \text{ lamps.}$$

The power was.....168.4 H.P.

Giving to the indicated horse power

$$1375 \div 168.4 = 8.16 \text{ lamps.}$$

* The conductors were insufficient, occasioning a loss, that increased with the increase in the number of lamps.

The resistance of the magnet circuit was now 3.28 ohms, with 108 volts pressure, representing

$$\frac{108^2 \times 44.3}{3.28 \times 33{,}000} = 4.77 \text{ H.P.}$$

Substituting this in place of 2.45 H.P. in the first trial, we have 21.48 H.P., which, deducted from 168.4 H.P., leaves net 146.92 H.P.

This gives 1375÷146.92=9.36 lamps per H.P.

It will be seen that the losses of efficiency due to undiscovered resistances are only

In the first case, 10—9.45=.55 H.P. per lamp,

In the second case, 10—9.57=.43 H.P. per lamp, and

In the third place, 10—9.36=.64 H.P. per lamp,

Averaging 5.4 per cent.

The friction in the journals of the armature, when driven in this manner, does not increase with the resistance, and, on account of the action of the reciprocating parts of the engine, that in its bearings is also nearly a constant quantity, whatever the load may be.

The above figures show this very clearly, the subtraction of the friction diagram in each case exhibiting substantially the same net power per lamp.

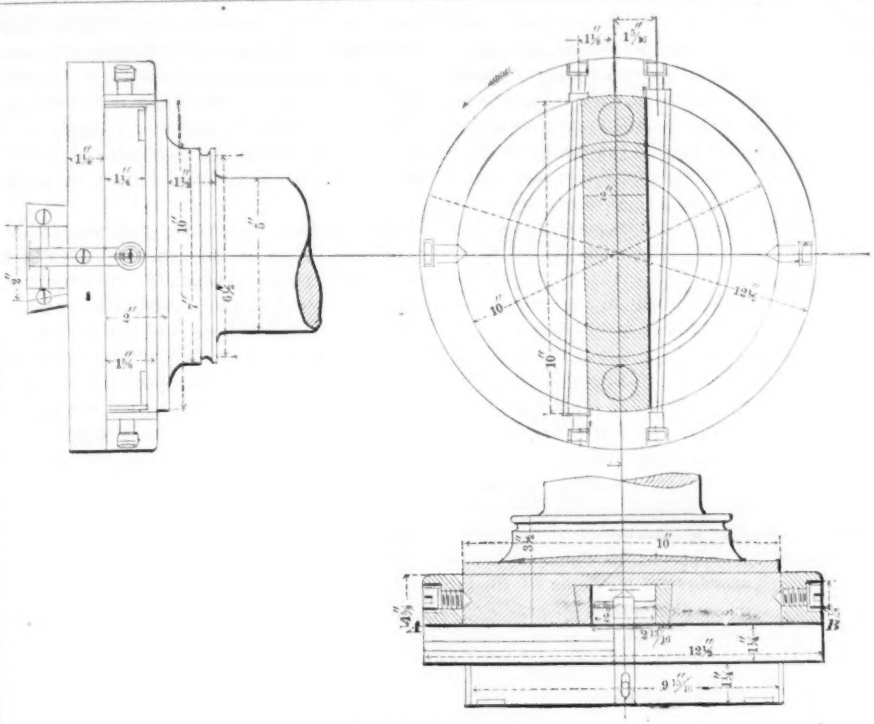


FIG. 5.—COUPLING.

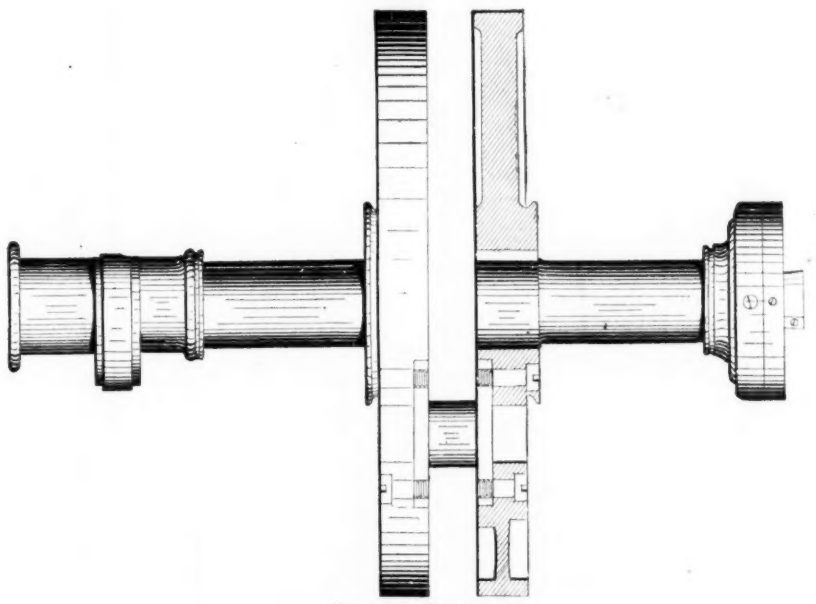


FIG. 3.—CRANK.

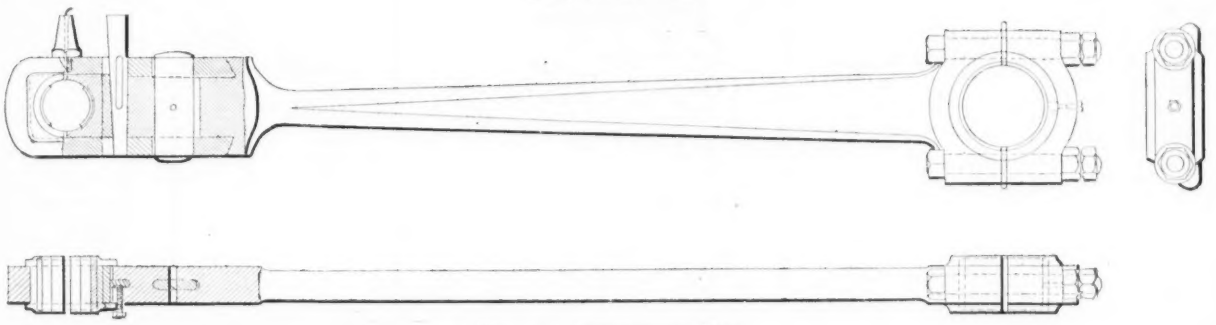
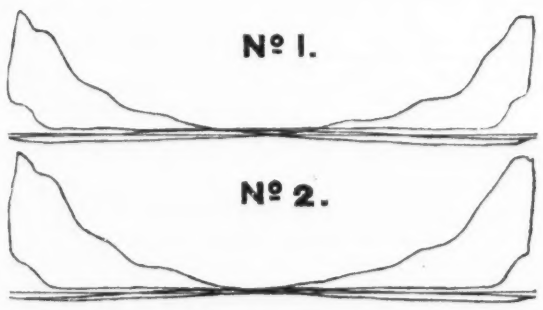


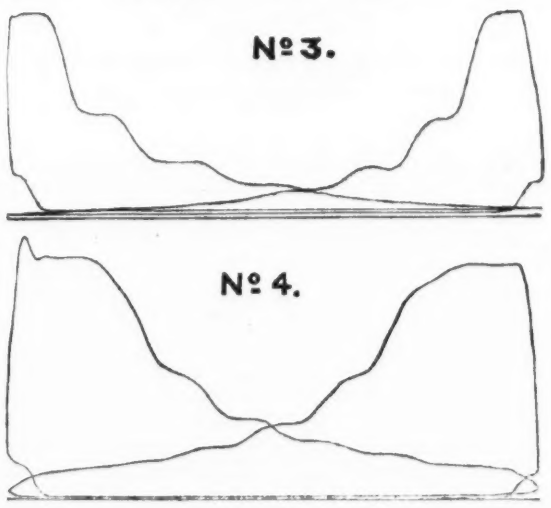
FIG. 4.—CONNECTING ROD.

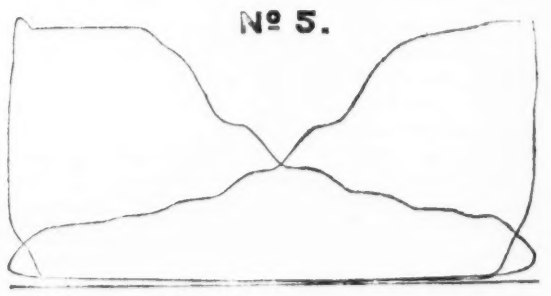
Engine Lathe Construction and Shop Matters.

A western correspondent writes with reference to machine tool construction, as well as about various shop matters, as follows:

"I enclose two cuts of engine lathes, each representing a lathe of about the same size, to show the different construction of head stocks. You will see that so far as strength is concerned they are about alike, but you will also see that the construction of one of them permits the use of a large gear wheel on the spindle, and a correspondingly large cone, while that of the other compels the use of a small gear and cone. I prefer the one with the large gear wheel, cone, &c., and I don't think it a simple matter of opinion. With the large gear wheel there may be a greater difference between the size of the pinion on the back shaft and the gear, thereby increasing the driving power. It is surprising that so many tool builders pay so little attention to the head stocks of their lathes. There are many 18 and 21 inch swing head stocks that are nothing but 12-inch heads on stilts. If the cone makes sixteen revolutions to one of the spindle it will be a much superior, so far as that goes, to a lathe geared eight to one.







Wide cone faces will not balance the matter.

Bodmer's plan was to have the cone made so large that the belt would just clear, and the gear wheel one speed larger with a hole in the head stock to enable it to clear.

His plan for the loose head stock was to have the spindle go entirely through, and the fly-wheel travel back and forward with it; I see a Delaware firm practices this plan. The nut is made fast to the headstock by a wing which acts as a guide pin in a slot through the spindle. No matter how far the spindle is screwed out it has always the same length of bearing.

Opinions differ about the shape of the loose, or following headstock. The modern plan of having a slot and tightener at the end is a very simple and good one. I prefer the head so constructed that the bolts for holding should be as short as possible.

About flat or angular shears there are great differences of opinion. Some makers, in order to make them wear longer, do not allow the V's of the carriage to bear at the bottom, but they will wedge down where the pressure of a cut is applied.

I recollect working in Hoe's printing press works in 1850, and a beautifully proportioned and finished lathe came (from Freelands I think) with flat shears nicely scraped. I remarked that the carriage would wear longer than if on V's.

The man in charge said "Yes, but it would not move so easily," adding however, "Nothing could work easier than this does." Col. Hoe told him to be careful and lay his tools on a board and take good care of it. He said he "would not lay sixpence on it." The Colonel was right. Some men of the rushing school make new and expensive tools, after a few years' use, only fit for the scrap heap.

What is the use of making nicely-finished, case-hardened wrenches, and then having them battered out of all shape by rough-and-ready fast men? Machine tools are money, not chopping blocks.

The rushing, rough-and-ready chap is sometimes better appreciated out West than a good man. There was a first-rate workman who came out here some years ago from an Eastern shop. I never saw a better lathe-man; whether on wrought iron, cast iron or brass, he was equally at home. Everything he did was about right, and the way he finished a tangent, where the line strikes the curve, would have delighted Chordal. He was as particular in the grinding and shape of his tools as in his work, and all wrought-iron jobs were beautifully water finished, without the aid of files or emery cloth.

The boys appreciated his skill, but the old-fogy class never appreciated or forgave him. "Too slow," "What's the use?" "Who couldn't do a good job in the time he takes?" "Won't make steam any better," were the remarks that were freely passed.

There is no one so firmly entrenched in his own convictions as a rough, coarse workman.

Steam Power for Sailing Vessels.

A correspondent, after referring to a recent editorial in the AMERICAN MACHINIST on the subject of auxiliary steam power for sailing vessels, writes as follows:

"The subject is one that I am deeply interested in, as it will give a new lease of life to sailing vessels. Had it not been for this, the days of sailing vessels would undoubtedly have been numbered, and the verdict might have been, 'Killed by steel and steam.'

"In order to secure economy while the steam power is not required, the screw must be fitted so as to be drawn up clear of the water, or, instead of three or four blades, it must have only two *folding blades*. By this means, the sailing qualities of the vessel will not be interfered with by the drag of the screw—a very important matter.

"It will be a great aid to vessels that strike calms or 'doldrums' to be pushed along a degree or two, or until they catch a fresh breeze.

"Another important advantage will be that vessels fitted with this modern 'pusher' will lie a point or two closer to the wind, which would be of particular advantage in the case of fore-and-aft rigged vessels (schooners), and may, in the course of a few years, work a complete revolution in the coasting fleet.

"The one item of *towage* is a large expense to the owners of coast traders, and the addition of a small steam engine will effect an important saving.

"In respect to this matter, all who are interested in shipbuilding and marine engineering will be gratified that attention is being called to it, and that eminent engineering firms are engaged in the construction of machinery for the purpose."

Strikes have caused a rise in iron and building materials, thus stopping some contracts.

New Air Compressor for Hydro-Pneumatic Elevators.

The accompanying engravings represent two views of an air compressor recently built by Weeks & Halsey, at their shops, corner of Front and Pearl streets, Brooklyn, N. Y.

This compressor forms part of a complete plant of elevating machinery for the city of Stockholm, Sweden, and is to be be placed in a tower standing in the Stadsgarden. This tower is connected with the adjoining high ground of Mosebacke by means of an iron bridge 480 feet long, of which 312 feet is a single span, joined at one end to the tower. The height of the tower is about 135 feet over all, but the descent from floor to floor is 112 feet.

Two independent quick-running passenger elevators are to be placed here, and suitable waiting rooms are provided at the top and bottom.

The sides of the tower are open, except at the top and bottom. The base is enclosed by a building 40 feet long and 65 feet wide across the wings, containing waiting rooms for passengers, ticket office, and entrance and exit passages leading to the elevators. The machinery is all placed in the basement.

The form of elevator adopted is known as the "Hydro-pneumatic," the invention of Mr. George Johnson, of Cincinnati. We illustrated and described this elevator in our issue of August 14, 1880, and will now simply say that it is of the class known as hydraulic; that is, it is operated by the pressure of water acting directly against a piston, which, as it moves forward, either pushes the car up ahead of it or draws it after it by means of hoisting ropes, which are generally passed over sheaves so arranged that the distance traveled by the piston shall be only a fraction of that through which the car is moved. It is peculiar to this elevator that the water, instead of being forced into tanks at the top of the building, is inclosed in a tank in the basement, and forced out at any desired pressure by means of compressed air admitted above its surface, from a reservoir, in which the pressure is maintained by means of a compressor, the operation being as follows:

The driver in the car, by pulling the hand rope, admits the compressed air into the water tank, and the water into the hydraulic cylinder through the hydraulic valve, which is arranged so as to open a little later than the air valve. This water, entering the hydraulic cylinder, pushes forward the piston, thereby raising the car. A reverse motion of the hand rope closes the valves, leaving the car supported firmly upon an incompressible column of water, and a further pull allows the air contained in the water tank to pass into the back end of the hydraulic cylinder, and opens the hydraulic valve. The weight of the car forces the water back into the water tank, and the displaced air passes, without expanding, into the space behind the receding piston, thus making the pressure the same on the opposite sides of the piston, thereby putting it in an equilibrium and not in any way retarding the descent of the car; that motion being entirely under control of the hydraulic valve.

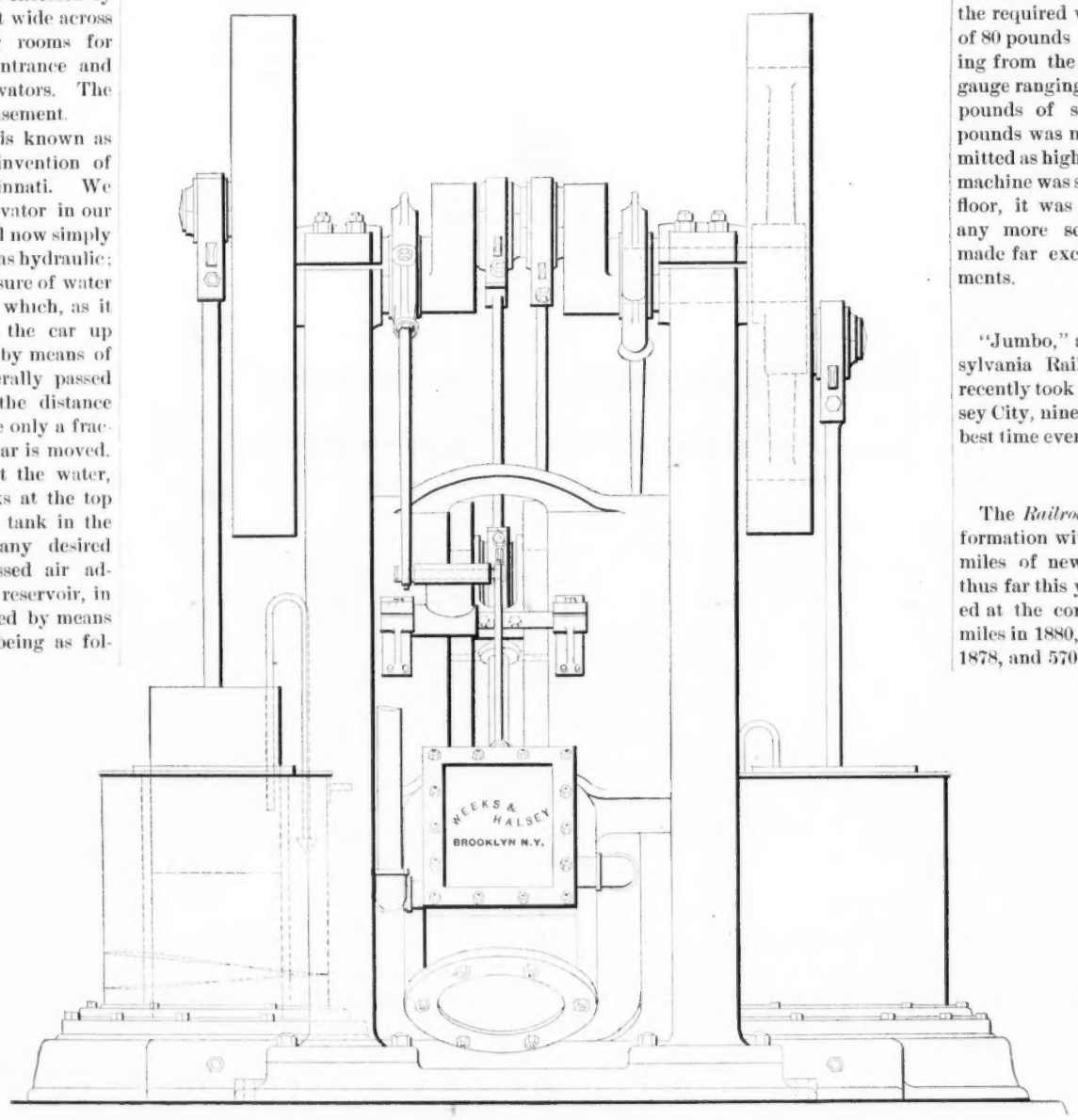
During the descent the compressor forces this air back into the reservoir. An arrangement for throttling the air as it enters the water tank, suiting the pressure to the load, effects a considerable saving of air in carrying light loads, and the economy resulting from pumping the half expanded exhaust directly back into the receiver is apparent without explanation.

A special form of compressor is required to handle this air to advantage, for, although less power is actually required to raise the air, already at considerable tension, to the full pressure than would be required to compress air of atmospheric pressure only, yet in the former case a much larger quantity of air is passed into the receiver at each stroke than in the latter, and with this increase of capacity comes a corresponding, though much smaller, increase of resistance, depending upon the ratio between the pressure of the air in the suction and that in the receiver.

The compressor must be able to automatically start up under any pressure whenever any air is exhausted into its suction; for, if it returns all the exhaust air, very little free air will be required.

The compressor shown in the engravings was designed in order to meet these requirements.

The engines, set at an angle of 60° with each other, have pistons 12″ diameter by 14″ stroke, and the two single-acting air cylinders have the same diameter and stroke as the steam cylinders. The relative position of the two steam cylinders, while it avoids dead centers, also gives a turning force suited to the varying resistance of the compressor plungers. The relative positions of the air



FRONT ELEVATION OF COMPRESSOR.

cylinder cranks are also carefully considered, so as to give the most uniform relation of the driving force to the resistance, and finally the arrangement of the steam valves is such as to modify the distribution of steam on the two cylinders to still further assist. The result is a much more uniform motion than could otherwise be attained, permitting the use of much lighter fly-wheels, and providing the ability to start off readily at any part of the stroke.

The supply of steam is controlled by a regulator of new design, which not only stops the engines when the air has reached the required maximum pressure, but also starts them, whenever any air is exhausted into the suction. The action of this regulator is instantaneous, it being very sensitive, and controlling the engines admirably.

By this arrangement the compressor in practical operation is only in motion during the discharge of air into its suction chamber. Working at full speed it passes this exhaust air, already charged with vapor and cooled by its expansion, directly back into the receiver, a large quantity at each stroke and then stops so that no power is wasted in useless pumping or in wiredrawing the steam. While the machine is running it is working to its proper capacity and economically, and when it is at rest only enough steam is circulated through the cylinders to keep them hot and dry.

The plunger connecting rods are of unusual length, and are provided at their lower ends with a ball journal 5″ in diameter, working in adjustable composition boxes. The plunger is 17″ long, and the bearing is near its center, by which arrangement the side thrust is evenly distributed. This construction also permits of the gradual rotation of the plunger, which secures even wearing.

The crank fly-wheels are 4 feet in diameter, and their momentum with the weight of the connecting rods is thrown directly upon the load.

The crank pins of the air cylinders are of steel and very large, and the crank pin to which the two engines are connected is as large as the shaft, the whole being forged in one piece. The bearings are all ample, and lined with composition.

The bed is made in three sections, the two outside sections supporting the center.

The air cylinder is surrounded by cold water, which first circulating through the lower head enters the tank, and is carried spirally around the cylinder, and drawn off at the surface. Perhaps the most effective cooling surface is furnished in the plunger, which is arranged with goose-neck pipes, that dipping into the water tank provide for a constant circulation through the plunger. The water thus circulated does not come in contact with the connecting rod brasses, these brasses being situated in a pot, which is let down into the plunger. This pot provides a reservoir of oil, which entirely surrounds the lower brasses.

The lubrication of the air plungers is effected by means of a small pipe, not shown in the cut. One end of this pipe is joined to the suction chambers, and the other inserted in a pot of lubricating mixture, heated by the steam pipe.

This mixture not only serves as a lubricant, but carried by the warm air it coats the interior of the pipes and tanks, and prevents corrosion.

The air valves are made entirely of phosphor bronze, carefully ground and fitted. Any one of them can be removed and replaced by a duplicate in a few minutes. There is no rubber or fibrous material about them to burn out. They are arranged to avoid the possibility of being drawn into the cylinder, and being in the bottom they drain away any water that may happen to get into the cylinder. The clearance can be made as small as desired, by adjusting the brasses in the plunger, which are especially arranged with liners for this purpose.

This compressor is intended to supply the air for two elevators, running constantly, and to maintain an air pressure of 80 pounds, with 60 pounds steam. In the trial, which was made to resemble as closely as possible the required working conditions, a pressure of 80 pounds was readily maintained, blowing from the safety valve, with the steam gauge ranging from 30 to 40 pounds. With 60 pounds of steam an air pressure of 112 pounds was maintained, and exhaust air admitted as high as 90 pounds pressure. As the machine was standing, blocked up on the shop floor, it was not considered safe to test it any more severely, especially as the test made far exceeded in severity the requirements.

"Jumbo," a new locomotive on the Pennsylvania Railroad, with seven-feet drivers, recently took a train from Philadelphia to Jersey City, ninety miles, in eighty minutes, the best time ever made on the route.

The *Railroad Gazette* of June 9th has information within a week of a total of 119¾ miles of new railroad, making 3,323 miles thus far this year, against 1,564 miles reported at the corresponding time in 1881, 1,590 miles in 1880, 661 miles in 1879, 413 miles in 1878, and 570 miles in 1877, 628 miles in 1876, 296 miles in 1875, 537 miles in 1874 and 1,171 miles in 1873.

By way of explaining the extremely rapid increase of new track it says:

"It should be remembered that one reason for the very large increase of track reported this year over last is the very mild winter, which allowed work to go on almost without interruption, while last year it was hardly possible to lay track anywhere north of the Ohio until late in April."

The management of the Baltimore and Ohio Railroad Employes' Relief Association has accepted the act of the Legislature of Maryland incorporating the association with savings and building features. Arrangements have been made for receiving on deposit the savings of the company's employees, allowing 4 per cent. interest and loaning money for the purpose of purchasing or improving homesteads at 6 per cent.

The Chesapeake & Ohio Railroad, which has only recently completed its western through connections, four-fifths of its last year's business having been local, has just closed a contract with Hazeltine & Arman of New York for building a grain elevator of one and one-half million bushels capacity at Newport News, Va., its eastern terminus on Chesapeake Bay. Work is to begin at once. The net earnings of this railroad for April 1882 were about double those for the corresponding month last year. This railroad is one of the new "trunk lines," and these facts indicate that a good part of the heavy shipments heretofore going to northern ports are tending southward.

LETTERS FROM PRACTICAL MEN.

Fast and Slow Melting—Straight and Contracted Cupolas.

Editor American Machinist:

Information on foundry matters is something that will always be of value to us all. A correspondent who signs himself "R" in your issue of June 3, seems to be in trouble, the cause being that he does not melt his iron fast enough. If there is anything that will make moulders growl, and that will tire out a foreman, it is to have a cupola melt slow. It is not only annoying to the employes, but it is expensive to the employer, causing him to pay wages to a large number of men that can do nothing for one or two hours but wait for their turns to pour off. In a shop such as Mr. "R" is running, the men are probably working under the ten hour system, which, in a jobbing shop, is to commence at 7 o'clock A.M., and go home at *bottom drop*, P.M. In a shop where the cupola takes two hours to melt what should be melted in one hour, it may be readily seen that the moulders could do one more hour's moulding if the slow melting cupola could be changed into a faster one.

Mr. "R" says he cannot see why he should do so much poorer melting than I do. He says that his coal is good, his iron is good, his cupola very nearly the size of mine, and the tuyere openings about the same, but that he has more blast pressure. He seems to have tried more and less pressure of blast, changed his fuel etc., but with no better results than the melting of 7,200 pounds of iron in two hours, in a cupola measuring, at the melting point, about 41". He seems to be in earnest in seeking for a remedy for slow melting, and as his inquiry seems to be pointed at me, I will tell him in a very few words what I think would help matters.

I would make the inside of the cupola entirely straight; if I could not alter the present one by taking out the boiler iron over the continuous tuyere, I would take it down and have a common straight cupola erected in its place. Instead of a continuous tuyere, I would have four common round tuyeres about 5" in diameter, that is if, by figures, I found the four 5" tuyeres to be of more area than the main-blast pipe, the size of which was not given. For small cupolas, I would not allow one to be made for me that was the smallest at the tuyeres. A cupola will get smaller at this point by being used, and sometimes it gets too small, and the first thing we know, we have a bunged-up cupola without the aid of the boiler makers.

For larger cupolas the continuous tuyere is good, as it brings the blast nearer the center of the fuel; but for a cupola the size and style of Mr. "R's," I do not approve of it. In a small cupola nothing is needed to bring the blast to the center of the fuel, and instead of the cupola being smaller at the tuyeres, I would rather have it the largest there. Wherever the blast goes into a cupola it soon burns the life out of the fuel, and the melting iron, dropping down from above, falls upon this lifeless fuel and is soon chilled by the direct force of the cold blast. This state of affairs, from the beginning to the end, keeps all the time getting worse in the large cupola as well as in the small one. In the large cupola however, there is more chance of the blast losing its force and coldness before it reaches the center, so that the fuel is given a better chance for thorough combustion, not having its life burnt out by a too rapid supply of oxygen. This permits of running a large cupola longer than a small one can be run.

As soon as a cupola begins to get black and cold at the tuyeres, we say it is bunging up. This is true; and not only is the entrance being bunged up, but in the course of time the whole surface parallel with the tuyeres will be in the same condition, and as it increases, the slower will be the melting, until no melting can be done. We then drop the bottom and have a good time trying to get a hole through the bunged-up cupola. The next morning we will hear some grumbling when the melter comes out to get a breath of cold air, after trying to pick the cupola out.

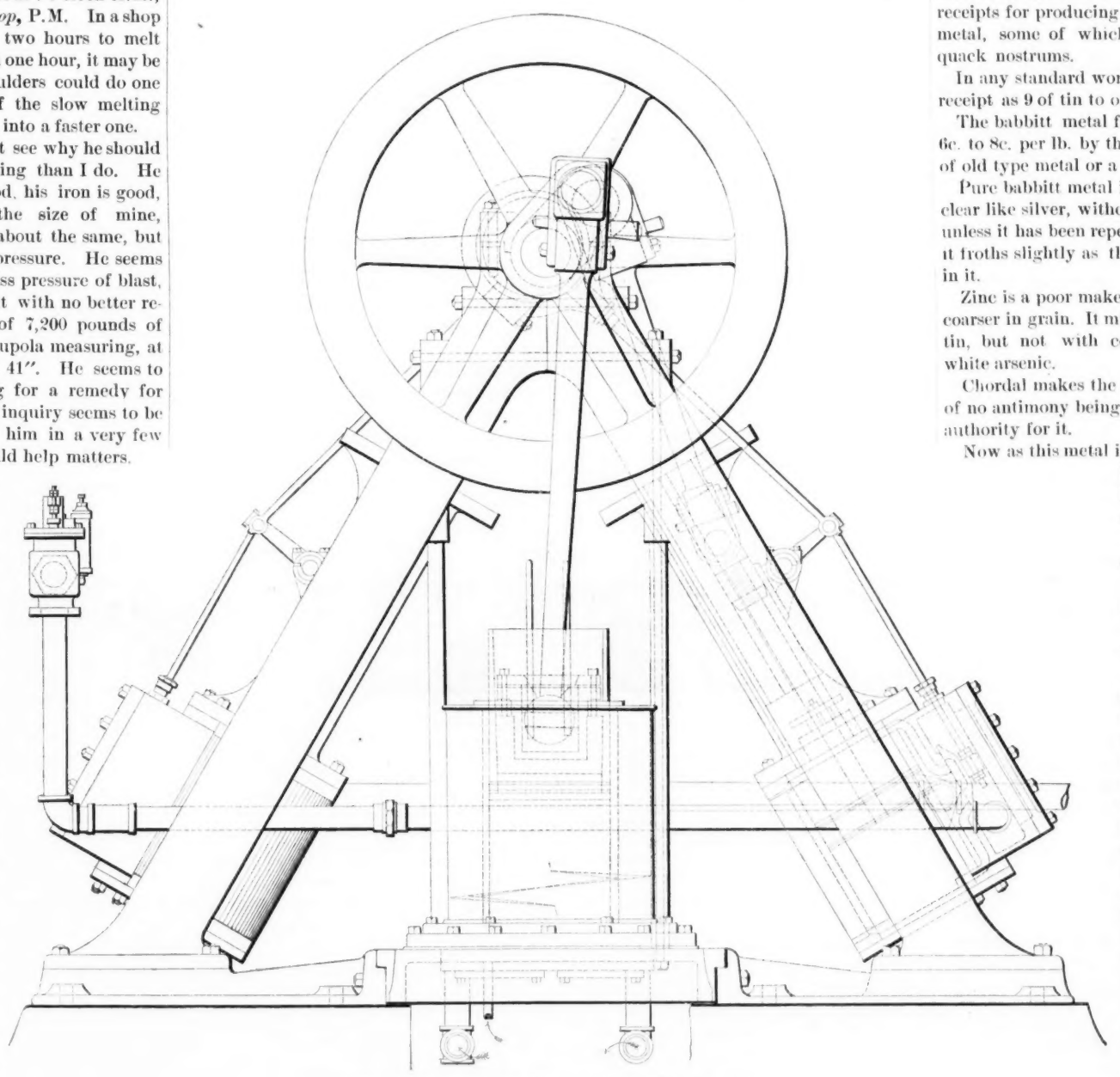
There are other things besides blast that help to bung up a cupola, such as improper charging, dirty iron and fuel, etc.; but, allowing that everything is done right, the cold blast will of itself accomplish it in the course of time.

Mr. "R" says he thinks the continuous tuyure is as good as the three openings. On this point I differ with him. I think that by using the three openings the blast is admitted into the cupola without having a chance to bung up so much in circumference of the inside, and also that it can be opened up or cleaned out much better, should it get so bad as to prevent the entrance of the blast.

I have often thought that the simpler the construction of a cupola, the better will be the results, and the longer I live the more I believe this to be true. Just take a good look at the inside of a bunged-up cupola, and then think how long and how much work it would require to keep any portion of it in an octagonal, hexagonal, or any analogous shape, and I think you would conclude that such forms were not desirable. A plain, round, straight-lined cupola, made with the bottom larger than the top portion, is the best for cupolas under 30". Above 30" there will not be any trouble from having the bottom and top of the same diameter; and, to my mind, a cupola should not be smaller at the tuyere, unless more than 50" in diameter—inside measurement.

I would like Mr. "R" to write what he thinks of the plan of changing his cupola so as to be straight. The change can be made without a great outlay; and I would not so advise him did I not think his cupola would melt faster and longer by so doing.

Mr. "R" has taken a wrong meaning from the number of the fan I used. No. 45 does not mean the size of the fan wheel, but is the way the Boston Blower Co. has of grading the different sizes of their fans. By measurement the fan wheel is only 25", instead of being 45". From this explanation he will see that I did not lose so much blast by friction in my conducting pipes as he thought. There is often, in trying the pressure of the blast, a good showing of pressure in the pipe, or tuyere box, but when it reaches the center of the fuel the pressure will have decreased considerably.



SIDE ELEVATION OF COMPRESSOR—(See page 4).

For melting with coal, more blast pressure is required than when melting with coke.

Coke will melt iron much faster than coal, especially so when a fan is used to supply the blast for both fuels.

If Mr. "R" had a force blower to supply his blast, or would use coke instead of coal, it would somewhat improve his melting, but before he can do what would be called fast melting, I think he would have to alter his cupola.

THOS. D. WEST.

About Babbitt Metal.

Editor American Machinist:

Not long since Chordal wrote an article on babbitt metal, some parts of which were incorrect, while others were very pertinent.

He makes an error in the receipt.

Isaac Babbitt carried on a brass foundry on Harrison Av., Boston, just above what was then known as Hinckley & Williams' locomotive shop, and he patented a shell or box for receiving the metal, but not the *metal*. At first, as Chordal says, "the box was hacked out with a chisel," but afterwards countersinks were drilled and the metal run into these, instead of as you now see in the majority of line shaft boxes. The above style is still followed in some locomotive shops.

Mr. Babbitt patented the box, the Government gave him $20,000 for the best metal to line it with, and Mr. Babbitt gave the following receipt:

4 lbs. of copper.
8 lbs. of antimony.
24 lbs of tin.
—
36

This was called hardening.

For every pound of the above he adds 2 lbs. more of tin. $36 \times 2 = 72 + 36 = 108$ lbs. of babbitt metal. You see that when the melting pot is full, there is 108 lbs of metal. This is the original receipt, as I can prove by those who worked for Mr. Babbitt at that time.

Since that time different machine shops and brass foundries have formulated other receipts for producing what is called babbitt metal, some of which would disgrace any quack nostrums.

In any standard work I doubt if any such receipt as 9 of tin to one of copper occurs.

The babbitt metal for car axles is sold for 6c. to 8c. per lb. by the ton, and is composed of old type metal or a similar mixture.

Pure babbitt metal in a melted state, looks clear like silver, without any froth or foam, unless it has been repeatedly re-melted, when it froths slightly as though there were zinc in it.

Zinc is a poor make-shift. It is lighter and coarser in grain. It mixes tolerably well with tin, but not with copper, unless you use white arsenic.

Chordal makes the statement several times of no antimony being used. I would like his authority for it.

Now as this metal is sold for various prices let us see what the honest article actually costs.

4 lbs. Lake Superior copper at 18c.

8 lbs. of antimony at 16c.

72 lbs. of Banca tin at 22½c.

$0.72 + 1.28 + 21,60 = $23.60 for 108 lbs. of metal. Time, coal, etc., is another dollar, unless you have a furnace that has just been relieved, as there is in that case generally fuel enough left to run down a pot of metal. Now so far, the actual cost is $24.60. Add from 6% to 10% for profit, and tell us how a first-class babbitt metal can be advertised and sold for 14c. per lb., as is done every day.

The fact is the metal that sells for 14c. to 16c. per lb. costs from 8c. to 10c. per lb.

Here is an actual illustration that came to notice a short time since. Mr. S. comes to Mr. H. in a hurry, and says:

"There's a breakdown on a printing press; what can you sell us good babbitt for?"

"Thirty-two cents."

"We can't afford that grade. The 14c. is good enough."

The 14c. metal cost the melter about 10c. per lb., and the machinist charged 30c. for the same.

A fine article to line the boxes of some of Campbell's best presses.

The above is a fair sample of the business from Maine to Texas.

WALDO A. HOWLAND.

Lowell, Mass.

Differences of Opinion on Mechanical Matters.

Editor American Machinist:

Allow me to make a few remarks in this my first letter to you. I read with a great deal of interest and profit the discussions in the letters from practical men, and often be-

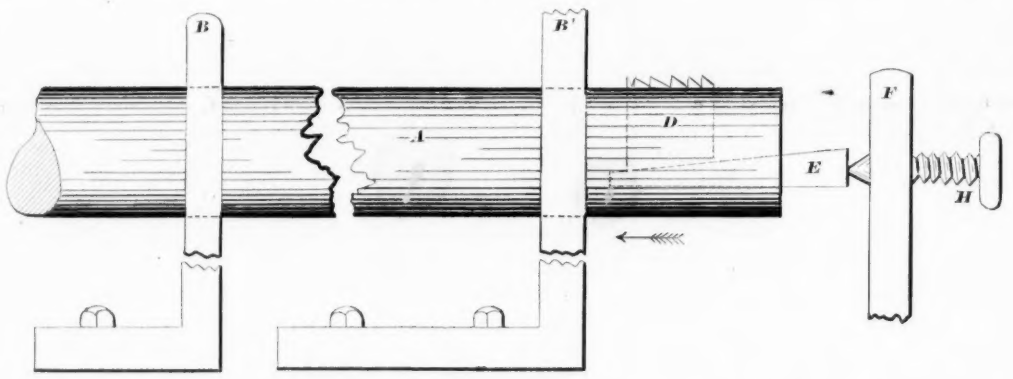
come amused when some one loses his temper because Chordal has said something that don't agree with him. What is the use of men "flying off the handle," because some one makes assertions that are not offered as strict mechanical doctrines or the result of large experience, but only the musings of an original brain, probably for the purpose of stirring up some sluggish mind possessed by some fellow described by Q. K. as too lazy to think. I do not agree with Chordal in all of his opinions. I don't know whether it would be creditable to me to do so. I often wonder if he don't do it just to tease some one who is vain enough to suppose he knows it all. Chordal is certainly worthy of being encouraged to present his thoughts to your readers in a style that is peculiar to him alone, although very many of your practical men have written very able and interesting letters, and those who have read them attentively can hardly have failed to receive some benefit. My advice to those who get angry at what they read, is to sit down and write something as able, and as good too, but be careful to keep even temper or all the readers who can smile will pay their compliments, including L. H. W.

Cincinnati, O.

Inside Splining.

Editor American Machinist:

It is often a vexatious question, how inside splining can be done more accurately and expeditiously than on an ordinary planer. It can be accomplished by an expert workman on a common planer, as far as accuracy is concerned, but it is impossible to do it very fast. Some time ago, I had about one thousand wheels to spline, not unlike an ordinary brake-wheel; and, standing aghast at the idea of doing it on a planer, I contrived a machine which worked to perfection both as regards speed and accuracy. In the sketch *A* is the shaft or cutter-bar, it being a running fit in the hole to be splined. *D* is the cutter; *B* and B' the supports; *B'* also serving for a face-plate to bolt the wheel to. A slot is cut in the shaft, so as to allow the cutter to drop in; also one for the wedge *E*. The cutter is made so as to cut while running in the direction of the arrow, the teeth being filed diagonally across the face, to prevent chattering. To operate, withdraw the wedge until the cutter is flush with the shaft, bolt on the wheel (using cam-bolts), screw the thumb-screw up until it touches the wedge, and start up. The feed is accomplished by turning the screw a partial revolution each stroke.



A reciprocating motion, proportionate to the depth of the hub is given to the shaft by the most convenient method.

Somerville, Mass. C. W. V.

Foundry Matters.

Editor American Machinist:

It would seem at first thought from the AMERICAN MACHINIST of May 20, that it would be well for me to say a few words to save my credit, but if your readers will read the letters that have appeared on the subject of iron melting, beginning in your issue of Feb. 5, 1881, I think they will agree with me that Mr. West in his communication of May 20, 1882, has set up a straw man and is, as Paul said, "beating the air."

It is rulable in any discussion to adhere strictly to the subject in question. Mr. West tries to convey the impression that if I had put three more such charges into the cupola as my last one was (as described in my letter of Feb. 18, 1882), I would have made a failure. All the iron that I needed for the heat described was 3,800 pounds, and I melted it with one of fuel to nine and a quarter of iron as stated. Mr. West is arguing from a supposition that *if* I had put in 2,550 pounds more iron, or three charges like my last, which would have made 6,350 pounds of iron, 415 of coke and 100 of coal, or he would have me with his supposed heat trying to melt a little over 12¼ pounds of iron to one pound of fuel, I should have made a failure, which I don't deny.

If I had asked Mr. West to have melted in his furnace in place of 8,000 pounds, 10,000 pounds of iron with 1,450 pounds of fuel, which would have been a little more than 7 pounds of iron to one pound of fuel, he might have thought I was in the straw man business. I believe that Mr. West, in his furnace could take off 5 tons of iron with 1,450 of coke, without any danger of having to handle frozen iron, or of bunging up his furnace.

If Mr. West's furnace is as he states it to be, and he has taken the care he says he has in instructing the cupola man and engineer, I can safely say, with Mr. Kirk, that it is the poorest showing of a heat that I ever saw or heard of. The old maxim that Mr. West just thought of when he was writing his reply to my letter, had no place in his mind when he was preparing the heat he describes, for there is not a shadow of penny wise in it, but there is the substance of a great number of pounds of foolishness in the use of surplus coke.

Mr. West may think that his cupola gave as good results as it was possible to obtain, but he is mistaken, for if he will give any foundryman that understands his business the management of his cupola under the same circumstances that he had the cupola in to start with, he will melt 7 to 7½ of iron to one of fuel, taking off from three to five tons of iron every heat.

Mr. West admits that I am right in stating that 7 to 7½ of iron can be melted to one of fuel, but finds fault because I did not give directions about melting in other or different sized cupolas. In my letter I only started out to give the facts of that heat. I described the cupola, and have nothing to take back, neither have I anything to add. I melted 9¼ of iron to one of fuel, and did it well, and I gave safe working proportions, viz.: 7 to 7½ lbs. of iron to 1 of fuel. I might have given my experience in different cupolas, but that was not the object of my letter.

Mr. West admits that I am right in stating that from 7 to 7½ lbs. of iron should be melted to every pound of fuel in a 24" cupola, and he as well as every practical man knows that in a cupola, 40" in diameter, and a heat in proportion, all things being equal, iron can be melted with less fuel than in a 24" cupola.

In my letter of April 18, 1882, I gave Mr. West my opinion of putting the fuel into the cupola, as he had previously described. Mr. West insinuates that I have garbled his statements. I am willing to leave this to your readers, and I think they will decide that, if he melts any other way than by having a hole in the center, he preaches one thing and practices another.

Mr. West says, in substance, that a foreman in a jobbing shop has something more to do during casting time than to be throwing iron in the furnace, which is true enough, but it is just as true that he is responsible to his employers for the way it is done.

C. M. WISHART,

Superintendent of Craver & Steele's Harvester and Self-Binder Works, Grinnell, Iowa.

Cornell University Statistics.

Editor American Machinist:

Your issue for June 3 contains an editorial on the department of mechanical engineering at Cornell University. In it you state that the number of students in that department is: Freshmen, 14; Sophomores, 7; Juniors, 7; Seniors, 0.

In this connection history and statistics are instructive. The University graduated its first class in 1869. The graduates from the department in question for the first five years were as follows:

1869	0
1870	0
1871	0
1872	0
1873	3

During the year 1873 Professor John E. Sweet became identified with the department. The record of graduates from it for the ensuing five years is as follows:

1874	1
1875	5
1876	6
1877	7
1878	11

At the close of the academic year 1878–9 the Professor withdrew. The record continues as follows:

1879	5
1880	3
1881	3
1882	0

But one inference can be drawn from this record, and that is the true one: To all intents and purposes Professor Sweet, during his connection with it, constituted the department. The reputation that he gave it, to quite an extent, still survives, and hence students enter as Freshmen in fair numbers.

These, however, soon become dissatisfied and gradually drop away into other courses of study, until, as we have seen, the department has no representation whatever in the present Senior class.

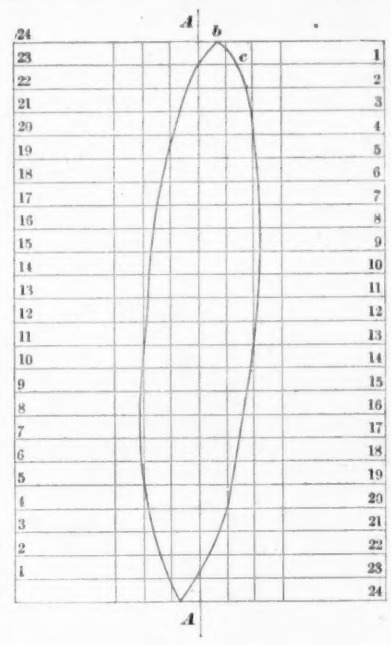
A GRADUATE WHO KNOWS.

One of the most striking characteristics of the machinery trade in Great Britain at the present time is the great amount of American-made material that is in use in some of the principal yards and workshops of the United Kingdom. The trade, too, is rapidly increasing.—*Engineer and Iron Trades Advertiser.*

An Easy Method of Making Motion Curves.

BY ANGUS SINCLAIR.

When a valve motion is properly planned, and ordinary care and judgment exercised in setting the valves, the steam will be distributed so that nearly an equal volume will pass in succession through each end of the cylinders. When this is the case, the exhaust notes will sound out uniform in pitch and period. Inaccuracies of the valve movement produce that irregularity of the exhaust known among railroad men as lameness. Among some classes of stationary and portable engines, a lame exhaust is the rule rather than the exception. In locomotive practice that phenomenon is not common, although in some localities it is heard oftener than it ought to be. Most men dislike to run an engine that has an irregular exhaust. There is a great difference in men in this respect, however. Some engineers merely experience a slight discomfort from listening, hour after hour away through the lone night, to the broken beats of a lame engine, while to other men of more sensitive ear the discordant sound is an actual torture.



When Billy Evans was running, a good many years ago, on a road in Missouri, he was assigned to an engine that had found a train between stations and was badly shaken up. When Billy started out his sensitive ear soon discovered that the engine was lame. On returning to the round house he reported the valves out of square, and got the machinists to run them over. But their work produced no improvement, although the process of setting was repeated several times. The lameness was not in time but in intensity. That is, the exhaust notes came out in regular succession, but one was heavy while another was light, indicating that one end of the cylinder was getting more steam than the other end. The man who set the valves protested that the engine *must* be square, and produced measurements of the valve positions. The figures showed that the increase of lead opening was regular; at full gear there was $\frac{1}{16}$" lead, at 12" it increased to $\frac{1}{4}$", and in the 6" notch the lead opening amounted to $\frac{5}{16}$".

"There," said the valve setter, "are the figures that cannot lie. How can that engine be lame?"

The proofs would have been perfectly satisfactory had the sound of the exhaust not continued to proclaim that the figures *did* lie. This was Billy's impression exactly, but he dared not bring up the subject again in the headquarters round house, where the convincing argument of figures had been hurled at his head, so to speak. But he set to diagnosing the trouble himself at the other end of the division where he was free to conduct his experiments unmolested. His investigations satisfied him that the tumbling shaft was sprung, and that the effect was to delay the cut off at one end while it accelerated the cut on the other stroke. After repeated trials Billy got his motion right by putting a piece of ¼" iron below the tumbling shaft box.

The art of valve setting has improved since that time, but blunders of a similar nature are not unknown even at this late day.

When an engine has been in trouble, it sometimes happens that difficulty is experienced in equalizing the port opening, or the cut off, for both strokes. During the process of valve setting, if the demand for the services of the engine are urgent, there is seldom time to study out the alterations necessary to effect complete adjustment, and the best that can be done is to get the motion as near right as circumstances will permit. Motion curves taken in a case of this kind supply a diagram for leisure study, the defects and the good points remaining equally apparent. The curves are the lines of a chart where investigation for defects can be carried on, and where the necessary changes may be critically determined.

A great deal has been done by Mr. Forney to popularize the method of taking motion curves, and to demonstrate their usefulness. His plans for taking these curves are very ingenious and accurate, but I find a method

proposed to me by Mr. R. W. Bushnell, master mechanic of the Burlington, Cedar Rapids & Northern Railway, easier than the methods recommended by Mr. Forney, and quite accurate enough for all practical purposes.

When the rollers for turning the drivers are under the engine, we take the true centers of crank positions in the ordinary way; then we go over the valves with the reverse lever in the notches nearest to the six and twelve-inch cut-offs; also, in full gear, for both motions. The eccentrics and rods are then manipulated to adjust the valve motion. We are then ready to take the motion curves. In most cases, the motion curves merely remain a record for subsequent reference, because the adjustment generally comes out right; but, if a difficulty be met with in harmonizing the motion, curves are taken which aid in solving the difficulty.

As a preliminary to taking the motion curves, a piece of clean board about 30″ × 12″ is selected. The particulars noted upon this board are represented in the accompanying cut. Through the center line *A A* is drawn, which, in subsequent operations, represents the middle of the valve seat. Across this central line other lines are drawn, one inch apart, to locate the various positions of the cross head. The valve is now placed on the center of the seat, and its location there recorded by tramming from a point on the stuffing box to a point on the valve stem. Measurements, which show how far the center of the valve has moved away from the center of the seat at each inch of the piston's travel throughout the circle of both strokes, furnish the points in the motion curves. Thus, with the lever in full gear, at the beginning of the forward stroke the center of the valve is drawn aside from the middle of the seat to the point *b*, the distance being equal to the lap and lead of the valve. When the piston has moved one inch, which is ascertained by the cross-head travel, the center of the valve has moved to *c*, and so on round the circle. The extent of the valve travel away from or towards the middle of the seat is found by use of the tram and a pair of dividers. Lines representing the edges of the ports are subsequently drawn, parallel to the center line, for convenience in analyzing the valve movements.

Grinding Processes.

We present this week the other of the two articles on grinding processes by John Richards, reproduced from *Engineering*.

THE POOLE SYSTEM OF GRINDING.

In commenting on modern grinding processes, it will be fair to commence with what is called the "Poole system," a method of grinding especially applicable to calender rollers, invented by J. Morton Poole & Co., and extensively carried on in their works at Wilmington, U. S. A., and introduced in Great Britain by Umpherston & Co., of Leith. It is a common thing for even skilled engineers to examine the operation of the Poole machines, and go away without understanding the principle on which they act. The operation is in fact one of the most intricate imaginable, and has perhaps no counterpart in mechanical manipulation. This we deem proper to mention at the beginning, so as to invite close attention to the description and diagrams, which at best must be an imperfect means of explaining a process wherein some of the most intricate points consist in the running action of the machines.

In the Poole system of grinding, the first thing to be pointed out is the use of two emery wheels, one at each side of the work, as shown in Fig. 7, where *a a* are grinding wheels, and *e* a roller to be ground. The two wheels *a a* are mounted in one frame, and positively connected together by screws and the ordinary guides, so that in effect they become a "pair of calipers" producing a positive parallelism of the roller *e*, unless the wheels should wear away as they traverse from end to end—a matter scarce supposable, because the transverse motion is quite rapid, and the wheels employed are of the hardest corundum that can be obtained.

It will be obvious that true parallelism must result from the fixed distance between the two wheels so long as both are cutting, but the straightness of the rollers, which is an equally important condition, must at the same time be secured. Calender rollers for the finer kinds of paper are made from 6 feet to 7 feet long, and in nests or piles of from 3 feet to 12 feet in height, as shown in the diagram, Fig. 8; in some cases, as many as eighteen have been mounted in one pile or stack, the number used depending on their truth. The straightness must be absolute, or within an inappreciable limit, otherwise the thinner kinds of paper, in passing through, would be pulled, and distorted by unequal tension and irregular compression. The limit of variation we are not able to fix, but imagine that $\frac{1}{1000}$ part of an inch in 6 feet would not be admissible.

This straightening is secured in the Poole system of grinding by mounting the two wheels on a massive swing frame poised on knife edges, as shown in the diagram, Fig. 9. The weight of the frame is to prevent oscillation from sudden resistance, and thus secure a steady, uniform motion of the wheels; and the sensitiveness to pressure is increased

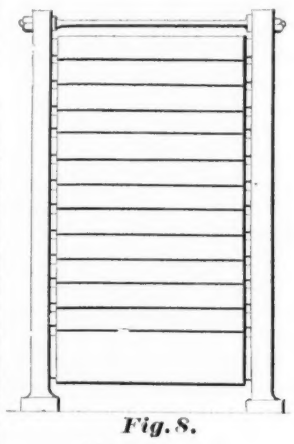


Fig. 8.

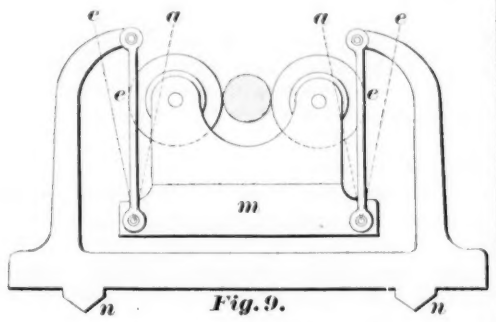


Fig. 9.

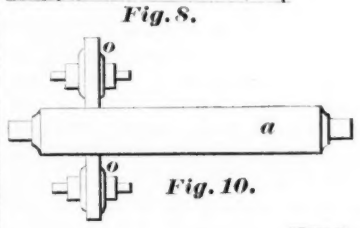


Fig. 10.

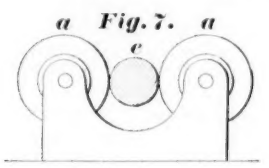


Fig. 7.

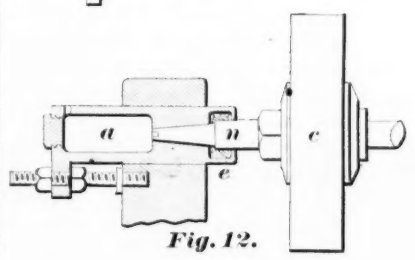


Fig. 12.

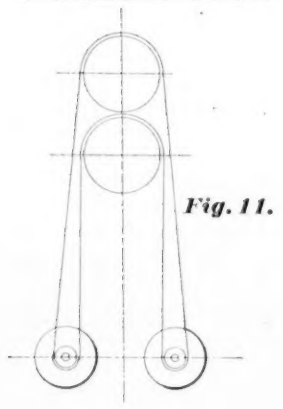


Fig. 11.

or diminished, as the work may demand, by shifting the top pivot to different angles, as shown by dotted lines. If the links *e* are set at an angle, as indicated by the lines *a a*, the swinging motion becomes more sensitive, but if moved to the position shown by lines *e e*, it will require more pressure to move the frame *m*.

The rollers, when first mounted, even after careful turning, are never truly cylindrical, and the first operation is to fasten the pivotal carriage *m* so that it cannot move transversely, and then grind the roller until it becomes cylindrical, as true as the ways at *n* will determine. Then the carriage is loosened, and the straightening process begins, and it is here that we come to that intricate point in the Poole process on which its importance

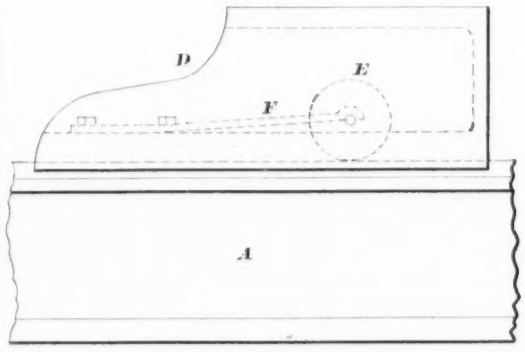


Fig. 1

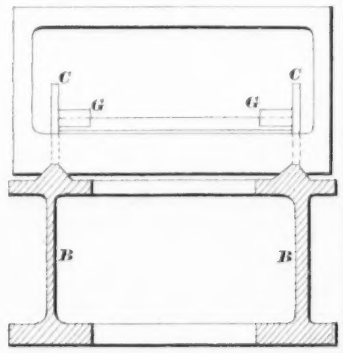


Fig. 2

mainly rests, and which has before been alluded to as difficult to explain.

The absolute straightness of the rolls, *independent of the ways on which the swing frame carriage runs*, seems a paradox. The fact is, of course, indisputable, thousands of rollers having been ground to perfect truth, and five independent machines operating before one's eyes is evidence enough so far as fact; but the principle on which the swinging carriage determines a straight line will still remain a kind of mechanical puzzle.

Let it be supposed, looking at diagram, Fig. 10, that the roller *a* is crooked, even to a minute degree, then the result must be that either the convex side will be ground off by the wheels *o o*, or else the heavy swing frame shown in Fig. 9 must vibrate backward and forward to the extent of the "crook" at each revolution of the roller. This latter can easily be imagined as impractical, and any other result must be a tendency to straighten the roller as rapidly as it could be ground away, and wholly independent of the parallel grinding ways beneath the carriage; perhaps a proper statement of what takes place will be that the *rotary axis of the roller becomes a guide for the swing carriage*. The rotary axis of a revolving body is, of course, a line of absolute truth if flexion is not considered, and as any bending of the roller from its weight would be in a vertical plane, the movement of the swing frame is not effected in this way, so that movement in an absolute straight line is the result. The rollers require to be not only straight but parallel, but in respect to this last requirement there need be no comment. Two wheels with their axes positively connected must produce parallelism in whatever is ground between them.

The sensitiveness of the swing frames on which the wheels are mounted is such that even the slightest touch will cause one wheel to cut more than the other, and in moving up the wheels, or feeding as it may be called, the handles of the screws are struck lightly with a light mallet of soft wood, care being taken that the blows, slight as they are, shall be given at right angles to the screws and transverse to the swing motion.

Some readers will, no doubt, be led to inquire why these sensitive devices are not disturbed by the stress of the bands which drive the emery wheels. This will be understood from Fig. 11, which shows the manner of arranging the bands, of which there are two for each wheel, that is four to a machine.

We have now said as much as circumstances will permit to be explained in respect to the Poole process of grinding. There are to be seen throughout the very complete works at Wilmington many things pertaining to grinding which are special and peculiar, matters apparently of but little import, and yet to the experienced suggesting experiments and expense. The process with which we have been dealing is now carried on in Germany and in Great Britain, and its value to the paper-making interest has been very great, both in a mechanical and economic way. Greater accuracy has been secured and the expense of making such rollers at the same time reduced.

This system of grinding has been described at some length to show how a large and important industry has grown out of improvements in grinding processes, made within ten years past, but there is no purpose of recommending, except in rare cases, the substitution of grinding for cutting operations in metal working.

There have been many mistakes made in attempting to supersede tool cutting by emery grinding in operations affording no reasons for such a change, and it is common to meet with engineers or skilled mechanics who will speak of the two methods of shaping and cutting material as though they were rival processes applicable to the same purposes. Perhaps one of the best illustrations that can be given of the difference will be to repeat a remark made by a shrewd practical mechanic not long since in respect to grinding. He said: "It consumes power enough to remove metal in chips let alone pulverizing it at the same time."

There can be no question that for shaping any metal soft enough to be cut with edge tools, that process is economically the cheapest, and as a rule the larger the chips cut away the less is the power consumed proportionately. The time and expense will also be found to follow approximately the same ratio. Grinding processes, paradoxical as it may appear, seem to be suited for the rougher kinds of shaping where exact dimensions are not essential, and for the finer kinds of shaping where exact dimensions are indispensable. As before pointed out, it may be called the first and last among metal-shaping processes, and by analogy represents the two extremes in respect to exactness.

The flying dust from emery wheels, which constitutes one of the most serious objections to their use in engineering shops, can be almost wholly avoided by water grinding or pneumatic fans; in many cases, where there would be difficulty in using water on the work, dust can be avoided by setting a vessel of water beneath the point of contact, so that the dust and sparks will be thrown into the water and collected there. This little precaution, which costs nothing, can be applied in all kinds of cylindrical grinding, and should never be neglected.

The steadiness of motion in emery wheels, on which their proper working depends, requires great care in balancing all parts, also in respect to bearings and driving bands. The diagram, Fig. 12, shows a method of mounting the bearings of emery wheel spindles, which has given satisfaction in some cases, and is quite inexpensive. The large chamber *a* at the back is filled with some kind of lubricating paste, which will melt at a low temperature, and the smaller chamber at *e*, next to the wheel *c*, is filled with fibrous packing, loosely pressed in around the spindle at *n*. This prevents flying emery dust from finding its way into the bearing, and, as the flow of spent oil is outward through this packing, nothing is by that means carried into the bearing. Hardened steel running on cast iron is perhaps as good as any combination that can be used for such bearings. Softer metals, such as brass and white alloys, "hold" the emery dust, while close-grained cast iron permits it to work out with the oil.

Shop Kinks.

No. 32.

By LEWIS F. LYNE.

ANTI-FRICTION ATTACHMENT FOR LATHES.

In turning short and heavy work upon lathes of 16″ swing and upwards, where it becomes necessary to move the tail stock frequently it is very tiresome work for the workman, who becomes fatigued and is unable to produce the desired quantity of work with the ease that it ought to be accomplished. This is owing to the excessive friction upon the ways, which may be due to imperfect lubrication, dryness, gumming oil and a variety of other causes. In the accompanying engraving is shown a very convenient and inexpensive device designed and used by George W. Richardson, of Boston, Mass., who has it applied to several lathes for fitting up the seats for his pop safety valves.

In the engraving Figs. 1 and 2, *A B* represents the bed of the lathe and *D* the tail stock. Two wheels or rollers *E C* are attached to the axle. The tail stock is cut through to allow these wheels to roll upon the top of the ways. The journals *G* are formed at the ends of two steel springs *F*, sufficiently strong to lift the tail stock when the binding nut is loosened. A felt wiper is attached to each end to prevent chips from getting under the tail stock. This device gives entire satisfaction.

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NEW YORK, JULY 1, 1882.

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The Demand for Competent Mechanics.

Several manufacturing industries as well as some railroads are employing fewer hands now than for a year or more past, yet skilled workmen are as much sought for as ever.

In a number of recent instances ordinary laborers have been discharged by hundreds because there was not work enough for them all, yet we hear of no surfeit of skilled mechanics in any locality.

The latter can command good wages and steady employment when common laborers are obliged to content themselves with reduced compensation and employment at irregular intervals. The usual time required to learn a trade is three years, and young men who are obliged to depend entirely upon their own efforts ought not to hesitate about going into the shop as apprentices. It matters not that they be older than most youths who are already out of their time. Hard persistent efforts for three years in the face of difficulties are to be preferred, if the result is superior advantages in solving the problem of life, to a struggle for twenty or thirty years for the necessaries of existence. Opportunities may generally be found if diligently inquired after, but they do not usually seek the individual.

Botch Work.

A printer has a very convenient expression by which to characterize a general lack of quality in a job. He calls it botch work. There ought to be an equivalent expression that should as correctly and with an equal economy of words characterize the multitude of small mechanical constructions that besets the purchaser. Reference is not had to machine construction, properly speaking, but to the thousand-and-one contrivances and conveniences that entice the buyer by their quality of handiness, and give out in some of their little mechanical miss-arrangements about the time he begins to appreciate them. There are screws that fail to serve any of the ordinary purposes of a screw by the time their utility is fairly comprehended; pieces that ought to remain united, but which part company after a spasmodic effort to maintain partnership, rivets, in name, &c., &c.

Manufacturers make "notions," some of them quite pretentious ones, that would be good for something if decently made, but which, because they lack this quality, are good—to sell. This is probably all they are made for, but when some article carries along with it an appearance of general utility that can't be dispensed with, it ought to bear some explanatory legend that would carry to a prospective purchaser that it was made to sell, or to use, as the case may be.

This may not be a matter for compulsory action, but its adoption would be a matter of considerable convenience to the purchaser.

Learn to do Something Useful.

There never was a time when the advice to a boy: Learn to do something useful, was more pertinent than it is just now. Why it is that the simple word "practical" has come to have so much significance is not worth discussing, but the fact itself is worthy of all consideration, and it is entirely unfortunate for those who do not comprehend it. How much a false idea of what constitutes an education may have to do with shaping things not altogether satisfactorily in this respect is not quite clear, but it is more than probable that the rectification of definition in accordance with common sense would do something towards setting matters right. There is sometimes a good deal in a name, and the absurdity of calling a man educated who has a knowledge of books without knowing how to put that knowledge to the primitive use of taking care of himself, in other words, to getting a living, and at the same time calling a man ignorant who has other knowledge that enables him to do something the world is anxious to pay him for doing, is becoming apparent.

In every large city there is always—no matter what the state of trade or business may be—a large army of unemployed; not of professional tramps, the class that do not work because it is their trade not to do so, but of those who are willing and anxious to work, and who sorely need the price of honest labor, but are not able to do anything well enough to create a demand for their services. In other words, with all their learning, they have never learned to do anything that the world has any particular use for. It would not seem to be going too far to call a man ignorant who, having arrived at years of discretion, was yet quite unable to care for himself; but the fact is that this army of unemployed are of the class popularly called educated, while the so-called ignorant class are, as a rule, quite able to take care of themselves.

The mistake should not be made, as we fear it sometimes is, of thinking that book knowledge is not in every way desirable; but, on the other hand, the mistake of thinking that such knowledge to *no particular end* will serve the ordinary purposes of life should be particularly guarded against as much the greater mistake of the two. Such knowledge, aside from its pleasures, may and does serve the most useful of purposes, but to do this its acquisition must not be the ultimate object. Instead of being the end, it must be the means to an end.

Aside from a limited few who may be required to perpetuate the knowledge, it will be of infinitely more service to a boy to learn how to build a steam engine, to mould a cylinder, to do a job of blacksmithing, or even to shovel gravel—to do any of these things, or something else in which a good many are interested, even passably well—than it will to learn all there is to be known of Greek and Latin verbs, which, right or wrong, it must be admitted, but few are particularly inquisitive about.

We by no means wish to be understood as insinuating that a knowledge of almost anything that can be gained from books may not be useful to a man engaged in the so-called homely affairs of life, nor would we in any way discourage, so far as is practicable, the acquisition of a liberal education, but what we do call attention to is the fact—too patent to be misunderstood—that a dependence upon such an education alone is becoming every day more and more insufficient to serve the purposes of a young man who has his way to make in the world; or, to state it more plainly, who is to be dependent on what he can do by virtue of what he knows.

In the nature of things, a large majority of men must gain the means of supplying their own wants by selling something that others want. Whether that something is an article of merchandise, or their own services in some capacity, success depends entirely on the ability to furnish that for which there is a demand. Whether the knowledge that will enable a man to do this is education, or something else, and just how much or how little of it comes from school or college, is not pertinent. However it is come by, it is what a large proportion of mankind will always need, and no boy can make a mistake in taking it for granted that he will be of that number.

Brooklyn Bridge Progress.

People living at a distance from this city, and who visit the Metropolis only at rare intervals, manifest great interest in the progress of the Brooklyn Bridge. About the first thing they are likely to ask a New Yorker who has taken a journey out in the country is: How is the bridge getting along? The New Yorker smiles a sad smile, expresses himself in anything but a confident style and quickly changes the subject. The fact is the people of these two great cities (aside from the officials) give but very little attention to that remarkable structure which has swallowed up about thirteen and a half million dollars of their money and which is awaiting the absorption of another million and a quarter dollars recently voted by the legislature for its "completion." Their interest in the matter crops out but once a month—immediately after the regular meetings of the bridge trustees. The people are usually informed upon these occasions that the work is in a very advanced state, that the trustees are waiting for another appropriation to push the structure to completion, that some outside parties are responsible for the slowness of operations and that several things must be done not calculated upon before (which increases the cost), in order to render the bridge more serviceable when finished. The monotony of these monthly statements has just now been somewhat relieved by the resignation of one of the trustees, Mr. Roosevelt, after three years service, who accompanies the act with a letter to the Mayor of New York city on the conduct of affairs since he has been a member of the Board. Although he had endeavored, as well as he was able, to inform himself, he declares: "To day I am but little better acquainted with the inner management of the department than I was when first appointed." Notwithstanding the secrecy maintained by the "inside" trustees, Mr. R. admits "some information would occasionally leak out which certainly surprised me." He accidentally discovered that telegraph and telephone companies were running their wires over the bridge without paying for a privilege which their own offers subsequently proved to be very valuable, and again, "the more astonishing fact that one member had without consultation with, or the approval of, the board, increased the weight of the suspended superstructure from 5,500 to 6,700 tons."

The uninitiated will doubtless regard these things as peculiar, to say the least. From an engineering point of view, the following extract from his letter will suggest food for reflection:

"I should have resigned sooner, but I waited only for one purpose; that was to ascertain conclusively whether the structure was safe beyond all peradventure before it should be opened to the public. My reasons for uncertainty were founded upon the reports of the chief engineer, Mr. Roebling. I cannot go into the detail of these, but will refer to the more salient contradictions they contain. He stated in one report that the superstructure was intended to carry 1,200 tons weight; a subsequent report admitted that he had added 1,200 tons dead weight in material alone! One report says that this addition of weight was made against his earnest protest, and that he resisted it for three months; another says it improved and strengthened the bridge immensely! One report states that he made the change only under pressure which he could not resist, and another that it was done of his own motion, and to meet the unexpected requirements of the travel between the two cities. I could quote many other inconsistencies, the last being on the question of the expense of completing the entire undertaking, which one report put at $600,000, and another, made within a month afterward, when no change of plan had been suggested and no additional outlay provided for, estimated the expense at double that sum; the items—for both were itemized reports—differing in every essential calculation. I am not an engineer, but when errors of hundreds of tons and hundreds of thousands of dollars are made, there cannot be much reliance placed upon computations of strength."

We have received a copy of the Register of the Lehigh University, South Bethlehem, Pa., for 1881-82. Tuition is free, and there are 144 students, of which seven are in the Senior or graduating class. The institution is technical in every sense of the word. There are four regular courses, viz: Civil Engineering, Mechanical Engineering, Mining and Metallurgy, and Chemistry. The object of the course in mechanical engineering is the study of the science of machines. We quote from the Register:

That the students may obtain the practical engineering data which they will most need when beginning their work as mechanical engineers, they are required to pursue a course of shop instruction which does not necessarily involve manual labor and manipulation of tools, but is principally devoted to familiarizing them with those points in pattern-making, moulding, forging, fitting and finishing, which they need to know as designers of machinery. Particular attention is therefore directed to the forms and sizes of machine parts that can be readily constructed in the various workshops, to the time that it takes to perform and the order of the various operations, to the dimensions most needed by workmen (in order that the students may learn to dimension working drawings judiciously) and to the various devices — ordinarily escaping the beginner's

notice—for increasing the accuracy of the work, durability of the parts, conveniences of manipulation and safety of the workmen. This involves acquaintance with the processes and machinery of the workshops, but it is the foreman's and superintendent's knowledge which is required rather than the manual dexterity and skill of the workman and tool hand. The acquirements peculiar to the latter are by no means despised, and students are encouraged to familiarize themselves therewith during leisure hours, but manual work in the shops forms no regular part of the course. On the contrary, the student enters the shop with hands and mind free to examine all the processes, operations and machinery, and ready at any moment at the call of the teacher, to witness an operation of special interest, or to examine into the causes of and remedies for any sudden break down.

* * * * *

That the students may learn to observe carefully and be trained to think and observe for themselves in these matters, there is required of them a full description of the various processes, operations and tools involved in the production of each one of a series of properly-graded examples of patterns, castings, forgings and finished pieces which are not being constructed in the shops at the time, and the drawings or blue prints for which have been given to them on entering the shops.

* * * * *

During the latter part of the first Senior term the whole class take up the design, of a steam engine, every dimension being determined by the students, and complete working drawings made. In the case of the simple machines and of the steam engine, the general plan or arrangement will be given to the students in the form of either rough sketches, photographs or wood-cuts. This work will continue to the middle of the last term of the Senior year. From this time on the students are expected to make original designs for simple mechanisms, the object of which has been fully explained. Throughout the course the work in the draughting room is carried on as nearly as possible like that of an engineering establishment, and special attention is paid to methods of expediting the work of calculation by means of simple formulas, tables and diagrams.

QUESTIONS & ANSWERS.

Under this head we propose to answer questions sent us, vertaining to our specialty, correctly, and according to common sense methods.

(214) L. B. S., Jordan, N. Y., asks: 1. Please tell me the horse power of an engine of 6½" x10", running at 200 revolutions with 100 pounds steam pressure, plain slide valve? *A.* The engine, if a good one, should indicate when properly loaded, about 15 horse power. 2. Is the pressure on a boiler more by opening a throttle valve suddenly than by opening it gradually? *A.* The pressure is no more, but the effect of instantly starting and arresting the motion of the steam and with it perhaps a large body of water, may by concussion endanger the boiler.

(215) H. B. G., New York, asks: Will you tell me how to find the area and the cubical contents of a sphere when the diameter is known? *A.* By area we suppose you mean the convex or outside surface, to find which multiply the diameter by the circumference. To find the contents, or volume, multiply the cube of the diameter by .5236. Example: What is the convex surface of a sphere the diameter being 5"? *A.* 5"×15.708"=78.54". What is the volume of the same sphere? *A.* 125×.5236=65.45, which is the volume in inches.

(216) G. A. A., Camden, N. J., writes: I am a draughtsman and am sometimes asked by a man who runs a planer to what angle some piece is to be planed, which I give him from the horizontal plane. He claims this is wrong, and refers me to his planer head to prove his assertion. The question I want to ask is, which is right? *A.* For all we can see you are both right. It is proper to measure an angle from a vertical, a horizontal or an inclined plane, and it is also proper to indicate on the drawing from what plane it is measured. At the same time if any number of degrees were spoken of without further reference, we should understand it to refer to the horizontal plane.

(217) R. R. H., New York, asks: Do you consider that the evaporation of 30 pounds of water into steam is the equivalent of a horse power in a steam boiler, and is it not so considered by mechanical engineers to-day? *A.* We have for some years been in the habit of measuring the horse power of a boiler by the number of times 30 pounds of water evaporated per hour under a pressure of from 70 to 80 pounds. Some engines require more water than this, and many require less. We believe it is quite generally considered by engineers that this is a fair average.

(218) X. P. W., Racine, Wisconsin, asks: 1. How many pounds pressure can I get with a screw 4¼" diameter and ⅜" pitch, a gear 38¼" diameter being attached to the screw and 5,000 lbs. applied at the pitch line of the screw? *A.* The circumference of the gear is 120" and one revolution moves the screw in its nut ⅜", hence, leaving out friction, the thrust of screw would be to the power applied as 120÷⅜=320 to 1. The power applied being 5,000 lbs., the thrust would be 320×5,000= 1,600,000. As for friction it is impossible to tell what it will be, but unless the length of thread is very great and the bearing surface excellent, it will be enormous. You will have to use best cast steel or it will give way by crushing. 2. Is there any data for friction of screws under considerable pressure? *A.* Not that we are aware of.

(219) A. H. G., Cincinnati, Ohio, asks: 1. Is it practicable to heat a building with exhaust steam from an engine, the heating apparatus being arranged as commonly found in business houses? *A.* As arranged for heating with live steam the main distributing pipe is usually too small for heating with exhaust steam, otherwise there will be no trouble. 2. Could I by exhausting in the heating apparatus, with a back-pressure valve set at 15 pounds, accomplish good results? *A.* You should be able to heat if your pipes and radiators are properly arranged with a back pressure of not more than 5 pounds. 3. Would it be cheaper to heat with the exhaust steam than with a separate boiler, and would any alteration of the pipes be necessary? *A.* There is good economy in the proper use of exhaust steam for heating. As to the arrangement of pipes, so far as the sketch shows your pipes are all right, except, perhaps, you propose to use both exhaust and live steam at the same time, which we should not advise.

(220) J. W., Chicago, Ills., asks: 1. Are pinions and gears to run together cut with the same cutter? *A.* No. 2. If the pitch and number of teeth are given how is the diameter found? *A.* We suppose you refer by this to the circumferential pitch, and you can use the following rule to find the pitch diameter: Multiply the number of teeth by the pitch and divide the product by 3.1416; the quotient will be the pitch diameter. Example: What is the pitch diameter of a gear the number of teeth being 100 and the pitch being ½",

$$\frac{100\times\frac{1}{2}''}{3.1416}=15\tfrac{91}{100}\text{ inches.}$$

3. Is the pitch line just one-half the depth of the tooth? *A.* No. The clearance increases the depth of tooth below the pitch line. 4. What is the best rule for finding the horse power of a steam engine? *A.* Multiply the mean effective pressure in pounds per square inch by the area of the piston in square inches; multiply this product by the piston speed in feet per minute and divide by 33,000. The quotient will be the horse power.

(221) W. S., Richmond, Ind., asks: Will you answer the following to settle a dispute. If I take three wheels and key them on a shaft, the shaft say 6 feet long; 1 six foot wheel on each end and a three foot wheel in the middle; put them on tracks, build up the middle track to the three foot wheel, and start them going say at 25 miles an hour, will the middle wheel slip or will it run the same as the others? *A.* The circumference of a 6 foot wheel is 18.84 feet and one revolution of the wheels would advance the axle on the track that distance. The circumference of a 3 foot wheel is only one-half as much, hence a revolution would only advance the axle one-half the distance. This being plain it is equally evident that either the 3 foot wheel will be slipped ahead by the traction of the two 6 foot wheels, or that the two 6 foot wheels will be slipped back by the traction of the one 3-foot wheel. We shall decide that the two 6-foot wheels will slip the one 3-foot wheel.

(222) J. H. T., San Francisco, Cal., writes: I have a portable engine with the check valve about five feet away from boiler. The pump plunger is ⅞" diameter with 12" stroke, the engine running from 190 to 200 revolutions per minute. The pipe from pump to boiler, and also the check valve is one inch. The water is heated after leaving the pump. Sometimes the check works steadily, but it is usually very noisy and wears out very rapidly. The pipes are clear. What reason can you assign for this, and is there anything wrong in the location of the check valve? *A.* In locating a check it is advisable to have a cock as near the boiler as possible with the check close to the cock. This provides for shutting off from the boiler at any time to examine the check. There is usually a little difficulty of the kind you describe with checks that pass hot water. We have frequently remedied the trouble by reducing the lift of the valve. Most commercial check valves have twice as much lift as they should have, and we presume this is the principal trouble with yours. We should, however, first put a light spring on the valve and if this did not remedy it then reduce the lift to 5-32". We think the spring will answer all purposes.

(223) J. R., Detroit, Mich., asks: 1. Will not changing the point of cut-off with a link change the lead? *A.* With the ordinary shifting link, that is one in which the link is shifted on the block, the lead varies with the different positions of the link. This link may be arranged, however, so that the lead will be constant for *one* direction of motion. With the stationary link, that is one in which the block is shifted in the link, the lead may be constant for motion in both directions. 2. What is the object of a cut-off valve on an engine, and would it not be just as well to put sufficient lap on the main valve to accomplish the same purpose? *A.* For very short cut-off an excessive lap on the main slide interferes with the action of the exhaust, and makes it necessary to provide more clearance. The object of the cut-off valve is to allow the main valve to be arranged for proper admission, exhaust and cushion, without reference to the cut-off. 3. What is a pump bucket? *A.* It is a species of pump plunger. 4. What is meant by exhaust lead? *A.* It is the linear distance the exhaust edge of the valve has opened the port for exhaust at the end of the piston's stroke. 5. How is it possible to force water with an injector against a greater pressure than that of the steam used? *A.* See answer to C. H. S., July 16, 1881. 6. Mr. Roper gives rules for the amount of condensing water required for a condensing engine and the size of air pump; also the rule for finding the length of safety valve lever. Are these rules correct? *A.* We have no doubt the rules are correct, but in the instance of the amount of condensing water required it is generally better to provide about 20 per cent. more than is given, which extra amount need not be used unless found necessary. 7. How many valves must an air pump have? *A.* It is not absolutely necessary that it have but two.

BUSINESS SPECIALS.

Transient Advertisements, 50 cts. a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday morning for the ensuing week's issue.

We receive numerous inquiries relating specially to matters of private interest. While desirous to oblige our friends, we would suggest, that an advertisement of two or three lines under this heading will usually develop the desired information easily and quickly.

Portable Forges, $10. Holt M'fg Co., Cleveland, O.

Presses & Dies. Ferracute Mach. Co., Bridgeton, N.J.

James W. See, Consulting Engineer, Hamilton, O.

Steel Name Stamps, &c. J. B. Roney, Lynn, Mass.

Latest and best books on Steam Engineering. Send stamp for Catalogue. F. Keppy, Bridgeport, Ct.

Foot Power Machinery, for workshop use, sent on trial if desired. W. F. & John Barnes, Rockford, Ill.

J. C. Hoadley, Engineer and Expert, 29 High St., cor. Federal, Boston, Mass.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Do you manufacture Hardware or House furnishing goods you wish sold in New York? If so, address Manufacturer's Agent, care of AM. MACHINIST.

Machinists' Bench Tools; largest stock in the United States. Send for Machinist Catalogue, 212 pages. Tallman & McFadden, 607 Market st., Philadelphia.

"Steam Economy," 124 pp., cloth, $1.00 (illustrated), points out remedies for defects in engines. Best indicator practice. A. Wilkinson, 123 n. 4th St. Phila.

Jas. F. Hotchkiss, 84 John St., N. Y.: Send me your *free* book entitled "How to Keep Boilers Clean," containing useful information for steam users and engineers. [Mention this paper.]

July delivery at Lowell, Mass., 3 Fifield 36" lathes. Now in Chicago, one 48" lathe. 3 Betts 36" Iron Planers. W. A. James & Co., 273 South Canal street, Chicago, Ills.

"Slide Valve Gears," by Hugo Bilgram, published by E. Claxton & Co., Phila., describes the easiest method known for correctly proportioning slide valves, link-motions and cut off gears; price, $1.00.

Russell & Struthers, Wax Process for making outline engravings. Specimens each week in the AMERICAN MACHINIST. We also do Map Engraving with best facilities. Russell & Struthers, 59 Park Place, New York.

If you desire to keep pace with the daily progress and development of Telephone, Telegraph and Electrical matters, have a copy of the NEW YORK REVIEW OF THE TELEGRAPH AND TELEPHONE sent to your address. Only $2.00 per annum. George Worthington, Editor and Proprietor, No. 23 Park Row, New York. P. O. Box 3329.

The Student's Illustrated Guide to Practical Draughting. Price, $1.00. Lectures in a Workshop, with an appendix containing famous papers by Sir Joseph Whitworth, on "Plane Metallic Surfaces," "Uniform System of Screw Threads," etc. Price, $1.00. Either work sent on receipt of price on application to the author, T. P. Pemberton, 142 Greenwich street, (P.O. box 3083), New York.

Bound Volumes and Patent Binders. We can furnish Volume 3 of the AMERICAN MACHINIST, containing the full 52 issues of 1880, or Volume 4, containing the 53 issues of 1881, neatly bound in cloth, ready to ship by express, for four dollars. Either volume unbound, three dollars. "Patent Binder" for the AMERICAN MACHINIST holds 53 weekly issues in good shape. Sent to any address by mail for one dollar. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton Street, New York.

"Extracts from Chordal's Letters," the most interesting mechanical book published. A great variety of mechanical and business topics treated in a wise and witty way that will be instructive to old and young mechanics, and interesting to everybody. As many as 150 copies have been sold in a single shop. Over 40 Humorous illustrations; 320 pages, 12 mo. Price, $1.50 per copy, by mail, to any address. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton St., New York.

Important to Millwrights, Machinists and Pattern Makers—I have compiled a complete and absolutely correct table of The Diameters of Toothed Wheels on Pitch Line, by which any mechanic can instantly find what he requires or wants, without calculating. This table should be in the chest of every mechanic and millowner, and in the office of every manufacturer, as it saves hours of time, and dollars of money. No algebra to learn, no arithmetic to study. I have also added the computation table of what is known as the "Manchester Principle." Price, $2 per copy. Address, Wm. T. Ross, care Bremaker & Moore Paper Co., Louisville, Ky.

MANUFACTURES.

The Bethlehem Iron Co. have purchased two of G. S. Strong's patent feed water heaters.

Supplementary letters patent have been issued to the Montreal Cotton Co., authorizing the increase of the capital stock from $500,000 to one million dollars.

M. C. Bullock, Chicago, manufacturer of the Straight-line Engine diamond drills and mining machinery, has organized his business into the M. C. Bullock Manufacturing Co.

The establishment of a Rubber Factory at Granby, Quebec, seems now to be assured, the contract for the buildings having been let. The Town Corporation voted a bonus of $5,000 to the enterprise a short time ago.

Joseph Stearns & Co., West 40th street, New York, are putting in a new boiler 6 feet diameter, and setting it with Mahoney's Universal Patent Furnace. This makes their third order for this furnace improvement.

The Pawtucket (R. I.) Manufacturing Co., is erecting a building 153x120 feet for the manufacture of bolts, nuts and machinery. Stephen A. Jenks is treasurer, Geo. H. Webb, Supt., and G. H. Fowler, agent.

The Suffolk Iron Works of Boston have been incorporated, with William Butterfield as president and James G. Drew as treasurer. Their business is to carry on, with a capital of $100,000, the casting, annealing and finishing of metals, and other cognate operations.

William P. Buckley, until recently foreman of W. S. Ellis' foundry, Pottstown, Pa., has become manager of Byer & Bro.'s foundry, in the same town. The *Pottstown Leader* says: "He is a gentleman having a thorough knowledge of everything connected with the foundry business."

Smith Brothers, of Brooklyn, N. Y., have just completed two steel boilers 60" diameter for Messrs. Beard & Robinson's Elevators, Erie Basin, Brooklyn, N. Y. They will be set with Mahoney's Universal Patent Furnace and fitted with his Patent Corrugated Grate Bars.

The Combination Gas Machine Co. of Detroit and 118 Maiden Lane, New York, are making a very economical and safe gas machine to use from one to a thousand burners as may be required. About 4,000 of the machines are now in use and a free pamphlet is printed which gives records of a large number of them.

The Delaware Locomotive Company, which is erecting buildings in South Wilmington, Del., has a capital of $300,000, and its works will cover about twenty acres. This company has purchased from the Suspension Car Truck Manufacturing Company the right to manufacture and supply their trucks.

The Tewksbury Automatic Elevator Co., 60 Temple Court, New York, are manufacturing a new freight and package elevator which has some novel and valuable features. Sixty of them have already been ordered, although but one has been fully tested in operation. Their factory in Newark, N. J., has been fitted up with new and modern machinery.

Williams & Kemp, Fayette and Frederick streets, Baltimore, Md., started a small machine shop a short time ago for general machine and engine work. They experienced some difficulty at first, but by the time they had everything in running order work began to come in and they are now very busy. A milling machine has just been added, and shortly some larger machinery will be placed in the shop. They have a new automatic cut-off for slide valve engines.

The Pennsylvania Bolt and Nut Works, Lebanon, Pa., have purchased 19 acres of ground for their works, and have commenced work on the first building. There will be a frame building 60 x 120 feet, to be used as a rolling mill. They calculate to have it under roof in 90 days. Their other buildings will be of brick, viz.: Nut and bolt factory, 80 x 120 feet; boiler house, 30 x 40 feet; burring room, 40 x 60 feet; machine shop, 60 x 120 feet, and and a three-story brick warehouse, 50 x 150 feet.

Weeks & Halsey, Brooklyn, N.Y., are now engaged upon another improved form of compressor, for use in rock drilling, refrigeration, and general transmission of power by means of compressed air. Believing the increasing use of compressed air demands the greatest economy in its compression, together with a simple and accessible machine, they have combined some improvements of value to that end, based upon practical experience with the machines and a careful consideration of the laws governing the expansion of gases.

The following parties have recently set boilers with the Jarvis Furnace: The Riverside Mills, Augusta, Me, (the third boiler); The Binghamton, (N. Y.) Hoe & Tool Co.; The National Brewing Co., of San Francisco: The Raritan Hollow & Porous Brick Works, Perth Amboy, N. J., (to burn screenings); St. Louis Ore & Steel Co., Pilot Knob, Mo., (to burn slack coal); Stark Mills, Manchester, N.H. (10 Corliss boilers to burn screenings and soft coal). The chimney of the latter establishment is being constructed on plans furnished by the Jarvis Furnace company. It will have a base of 14 feet, and will be 140 feet high. The core will be 72" at the base and, gradually expanding, will increase to 78" at th op.

Machinists' & Engineers' Supplies.

NEW YORK, June 15, 1882.

The supply market remains unsettled, and on account of the labor troubles most of the dealers have withdrawn all quotations. There is nothing in the way of novelties. The Pig Iron market is substantially unchanged, with a tendency towards firmness at present prices.

We quote No. 1 Foundry, $25 to 25.50; with fancy brands, $26; No. 2, Foundry, $23 to $23.50.

WANTED

"Situation and Help" Advertisements, 30 cents a line, each insertion. About seven words make a line. Copy should be sent to reach us not later than Thursday morning for the ensuing week's issue.

Wanted—Machinists for portable engine work. The E. M. Birdsall Co., Auburn, N. Y.

Wanted—Situation as Mechanical Draughtsman. Address, Draughtsman, Box 535 Central Falls, R. I.

Wanted—Situation as draughtsman. Qualifications, scientific and practical training. References. Address, Box 98, Westville, Conn.

Wanted—Situation as foreman of machine shop. Thirteen years experience in Western States. J.E. McConnell, Iowa City, Iowa.

A practical mechanical engineer and draughtsman, experienced in designing new machinery, desires engagement. B.N., care AMERICAN MACHINIST.

A mechanical and topographical draughtsman, experienced also as civil and mining engineer, is open to engagement. Address, Archimedes, AMERICAN MACHINIST office.

Wanted—A young mechanical draughtsman, a graduate of a Technical school preferred. Good reference required. Address, Jesse M. Smith, Mechanical Engineer, Detroit, Mich.

A practical draughtsman of nine years experience on locomotive work and general machinery wishes a re-engagement. First-class references. Address, Link Motion, care of AMERICAN MACHINIST.

Wanted—Situation at pattern making by a young man lately out of his apprenticeship where he can have a chance to improve. Address, G. E., care of AMERICAN MACHINIST.

Wanted—A first-class mechanic as Superintendent of Machine Shops, Foundry, &c. Must be thoroughly educated and have good experience in some well-organized shop from which he can bring reference. Answers will be considered confidential. Address H. G. T., care AMERICAN MACHINIST.

Wanted—A superintendent for a jobbing foundry in the immediate vicinity of New York City. Must be practical in all branches and thoroughly acquainted with the construction of patterns, core making, melting and moulding of all classes of light and heavy work. Address, D., this office.

For Sale—One 5x16 foot Iron Planer, one 17 foot English Edge Planer and one Pulley Lathe. S. L. Holt & Co., 67 Sudbury street, Boston, Mass.

Wanted—Steam hammer, capacity 4 inch iron. State make, size, condition and price. Webster. Camp and Lane Machine Co., Akron, O.

For Sale A beam engine, condensing, 34 in. cylinder, 48 in. stroke; Sickles cut off; now developing 300 horse power by card. Fly wheel 20 ft. diameter by 36 in. face. Can be seen running at the Brooklyn City Flour Mills, Jewell Milling Co., foot of Fulton street, Brooklyn, N. Y.

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Will be held in THEIR MAMMOTH EXHIBITION BUILDING, (the Largest in the United States),
In Boston during the months of September & October, 1882.
Affording the best opportunity for advertising, or of introducing to the public new inventions. Artists, Inventors, Producers, Mechanics and Manufacturers, from every nation, invited to contribute. The product of New England's hand and brain will be well represented. No charge for space. Blank forms for application to exhibit furnished free, upon application to
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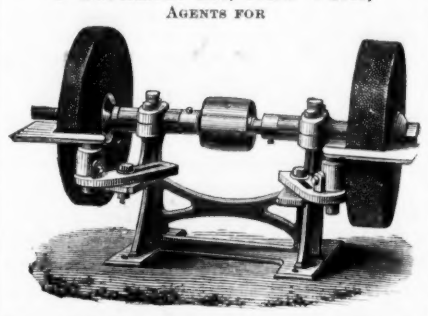

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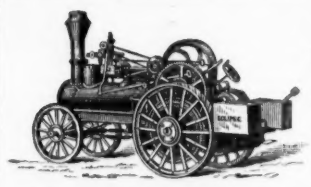

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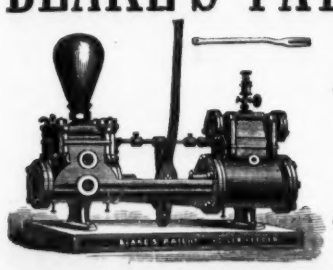

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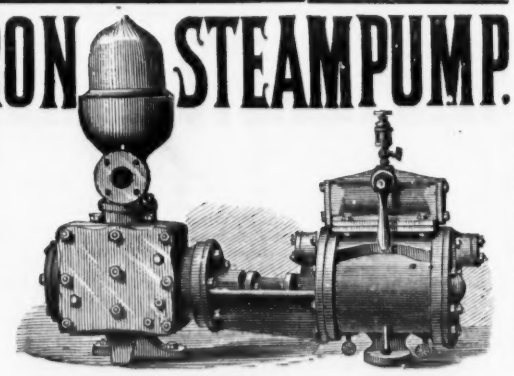

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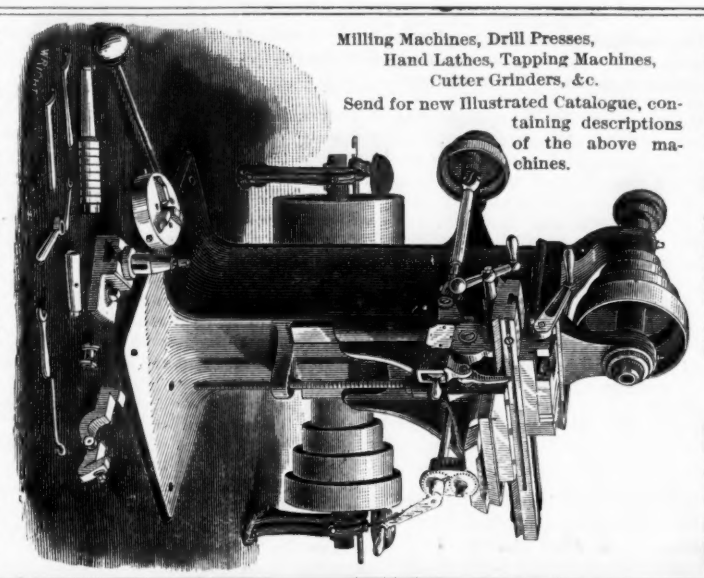

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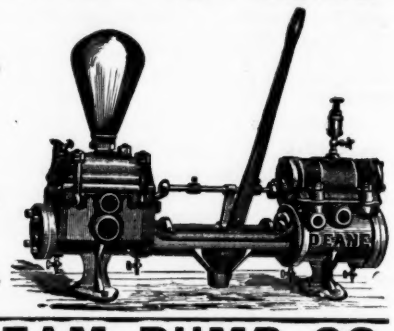

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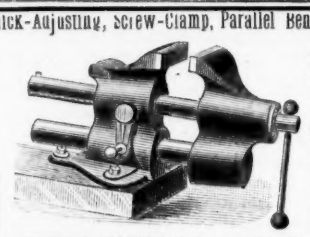

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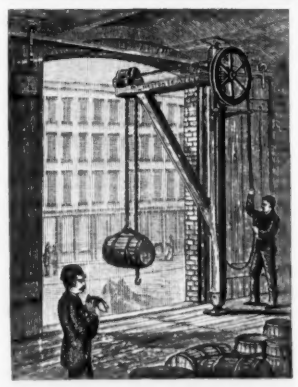

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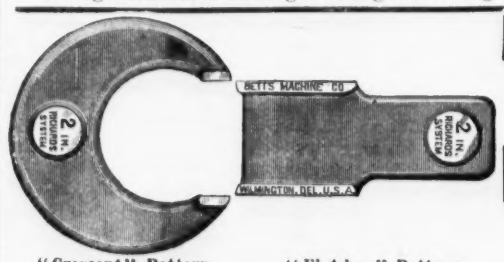

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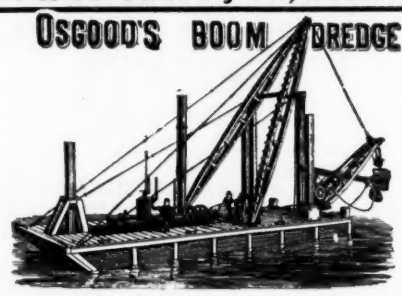

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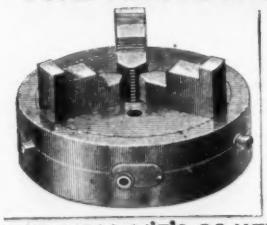

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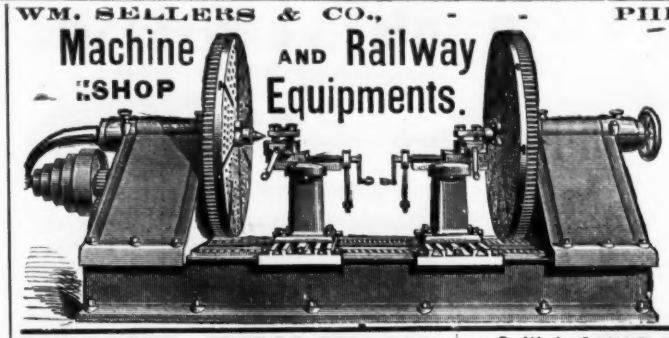

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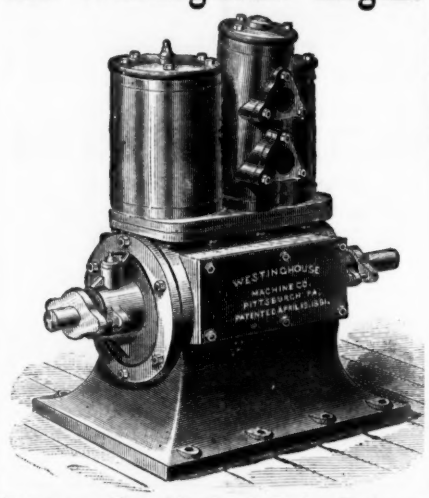

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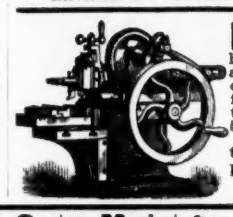

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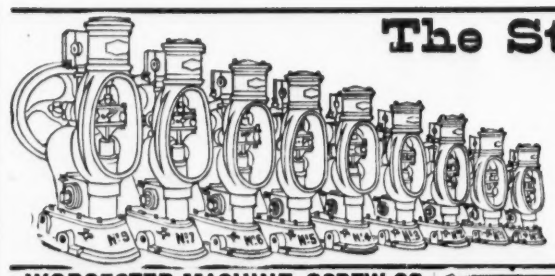

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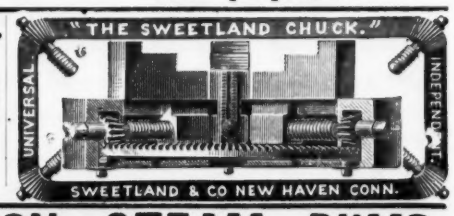

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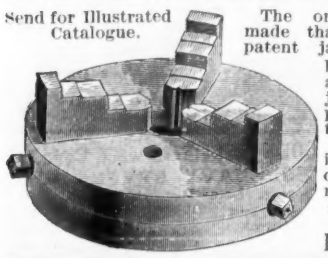

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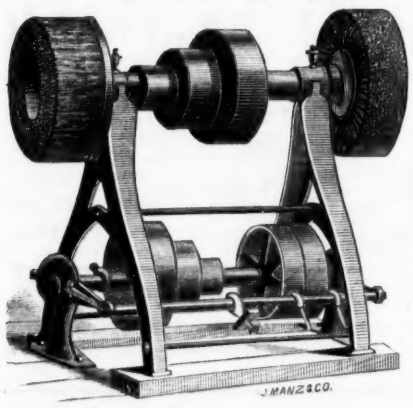

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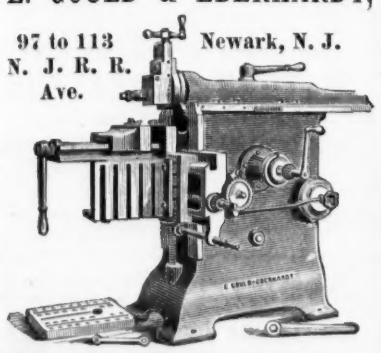

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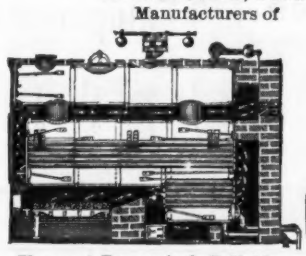

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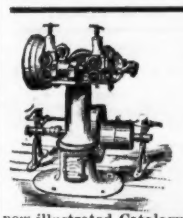

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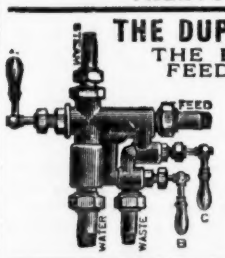

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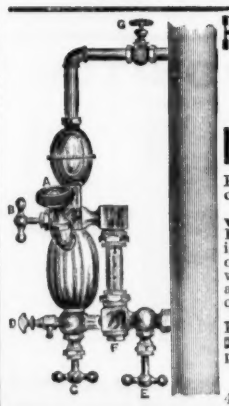

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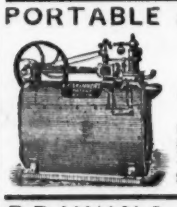

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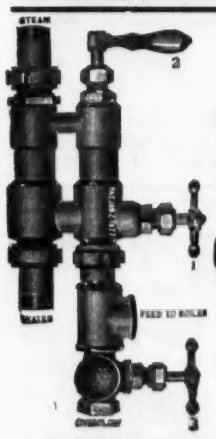

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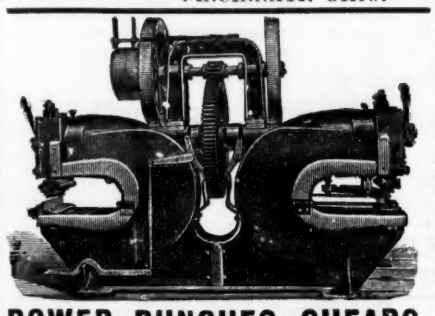

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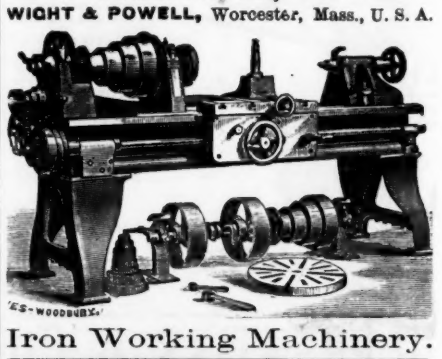

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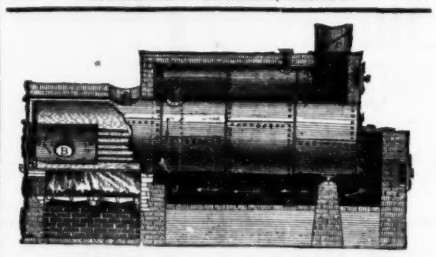

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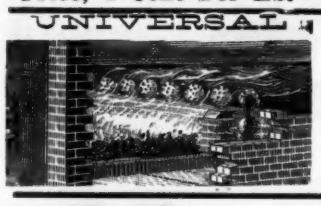

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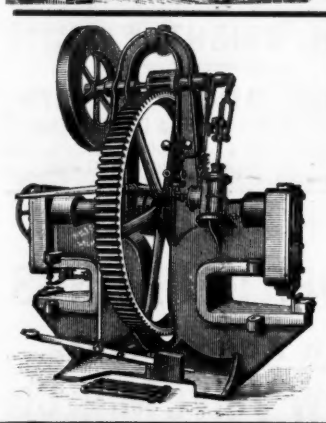

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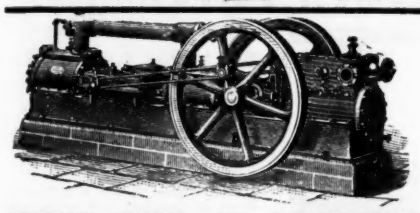

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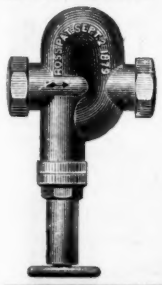

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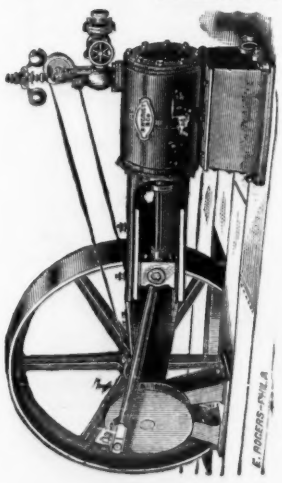

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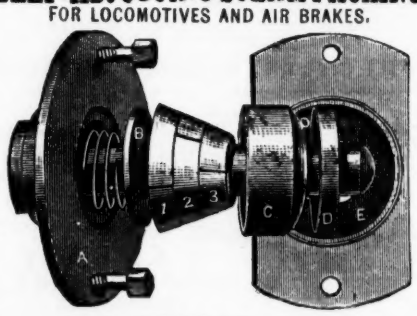

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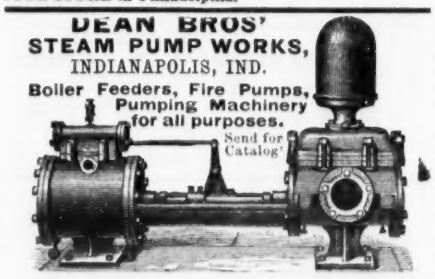

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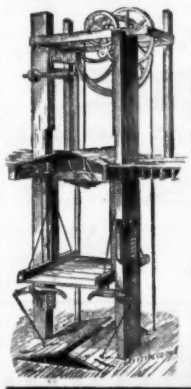

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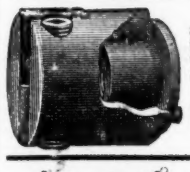

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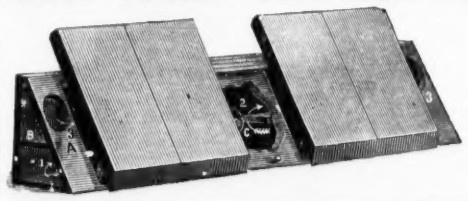

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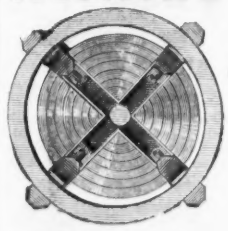

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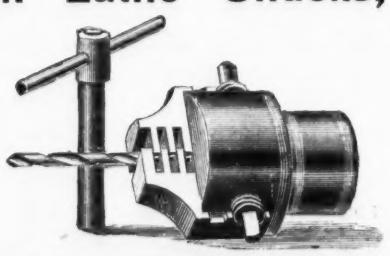

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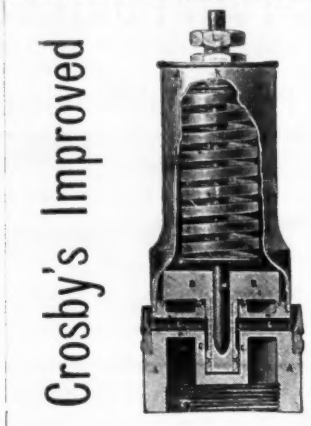

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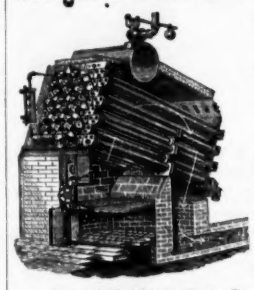

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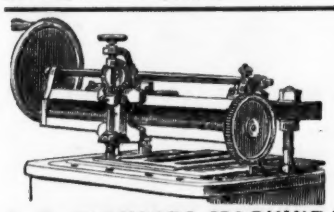

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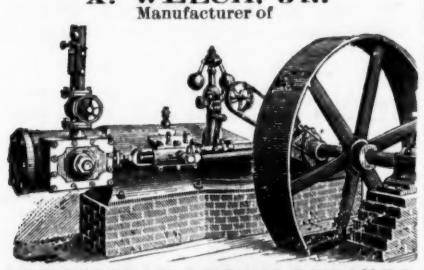

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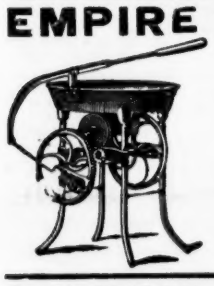

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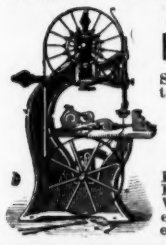

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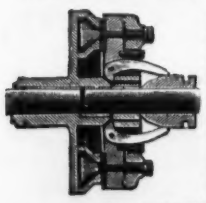

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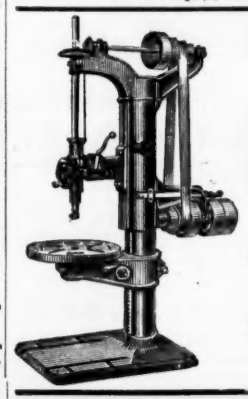

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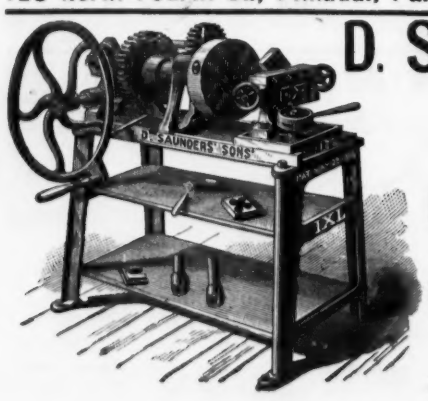

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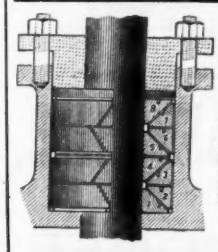

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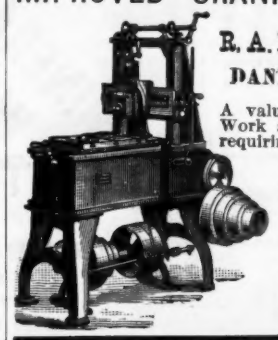

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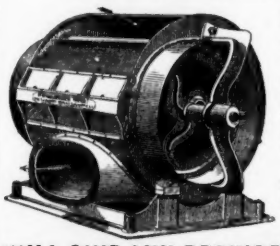

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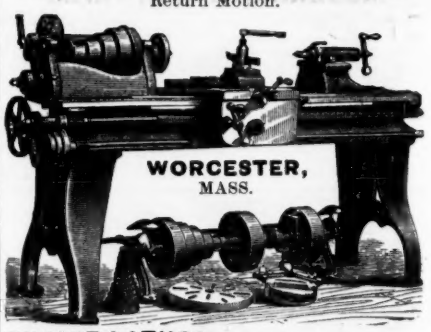

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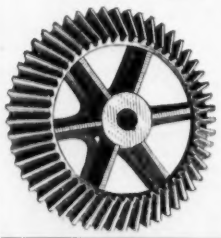

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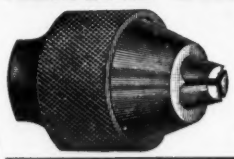

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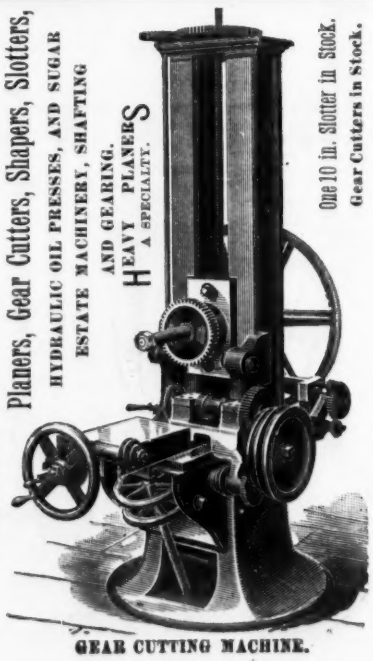

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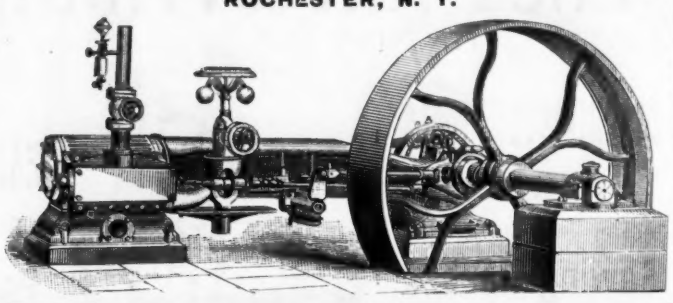

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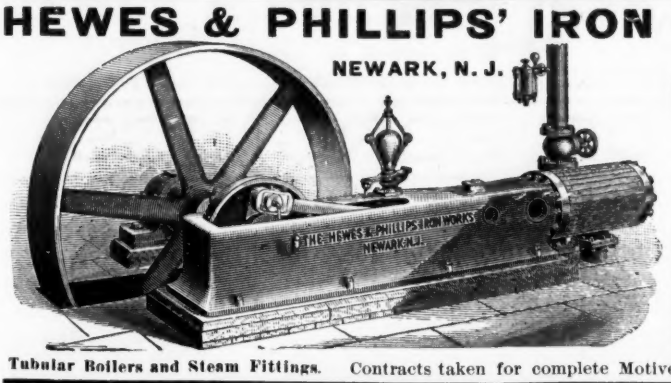

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28 inch swing,	18 foot bed.	Fitchburg.
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24 " "	14 and 16 "	Fitchburg.
21 " "	12 and 14 "	Blaisdell.
20 " "	14 "	Fitchburg.
20 " "	12 "	Fifield.
19 " "	10 and 12 "	Gray.
18 " "	10 and 12 "	Blaisdell.
17 " "	6 "	Johnson.
16 " "	6 and 8 "	Fitchburg.
14 " "	6 and 8 "	Fitchburg.
13 " "	8 "	Blaisdell.

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30 inch x 30 inch x 8 foot,	Fitchburg.
25 inch x 25 inch x 8 foot,	Fitchburg.
30 inch x 30 inch x 10 foot,	Hewes & Phillips
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60 inch radial drill, double-geared, self-feed, planed and slotted bed-plate with portable table. Best English make. Weight 4 tons.	
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25 inch, back-geared, self-feed,	Fitchburg.
25 inch, quick return,	Blaisdell.
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18 inch, " "	Blaisdell & Fitchburg.
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One " " 28 in. x 21 ft.	" "
One " " 24 in. x 14 ft.	Ames, "
One " " 24 in. x 12 ft.	" "
One " " 24 in. x 10 ft.	" "
Three Engine Lathes, 20 in. x 12 ft.	Ames. New.
Three " " 20 in. x 10 ft.	" "
Three " " 20 in. x 8 ft.	" "
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One " " 15 in. x 6 ft.	with Turret. Flathers. New.
Two Engine Lathes, 14 in. x 6 ft.	Star Tool Co. New.
Six " " 13 in. x 6 ft.	Ames. New.
Two " " 13 ft. x 5 ft.	" "
Six Hand Lathes. 12 in. x 5 ft.	Hendey. New.
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One 6 in. Stroke Shaper.	Boynton & Plummer.
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1 " "	14 in. x 6 ft.	Star Tool Co. "
1 " "	16 in. x 6, 7 & 8 ft.	Bridgeport. "
1 " "	13 in. x 6 ft.	Ames. "
1 " "	16 in. x 7 ft.	Ames. "
1 " "	18 in. x 8 ft.	Lodge & Barker. "
1 " "	24 in. x 12 ft.	Fifield. "
1 " "	26 in. x 12 ft.	Lathe & Morse. "
1 Plain Engine Lathe,	16 in. x 4 ft.	"
1 Engine Lathe,	30 in. x 16 ft.	Perkins. "
1 " "	22 in. x 18 ft.	" "
1 " "	16 in. x 6 ft.	" "
1 " "	24 in. x 12 ft.	Michel. "
1 " "	12 in. x 5 ft.	Prentiss. "
1 " "	12 in. x 4 ft.	" "
1 Fox "	15 in. x 5 ft.	Pike & Dean. "
1 15 in. x 4 ft.	Turret Lathe.	Lodge & Barker.
1 Planer, 22½ in. x 22½ in. x 5 ft.		A1 order. "
1 "	16 in. x 16 in. x 3 ft.	"
1 "	24 in. x 24 in. x 6 ft.	"
1 Upright Drill, 26 in.		Prentiss. New.
1 20 in. Upright Drill.		"
1 30 in. "	" "	"
1 10 in. Shaper.	Gould & Eberhart.	New.
1 Pratt & Whitney No. 1 Screw Machine.		"
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40	inch	swing,	16	foot	bed,	Triple	Geared	Gleason	Engine	Lathe.
40	"	"	12	"	"	"	"	"	"	"
36	"	"	18	"	"	Double	"	Fitchburg	"	"
28	"	"	26	"	"	Ames Shafting Lathe.				
26	"	"	25	"	"	Powell Shafting Lathe.				
26	"	"	20	"	"	"	Engine	"		
24	"	"	12	"	"	Fitchburg	"	"		
21	"	"	14	"	Lathe & Morse Engine Lathe.					

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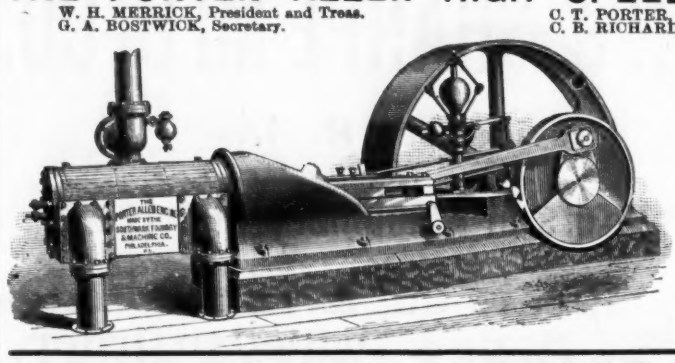

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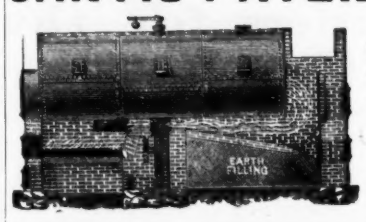

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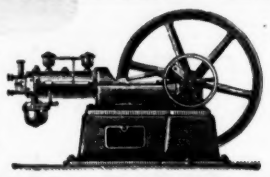

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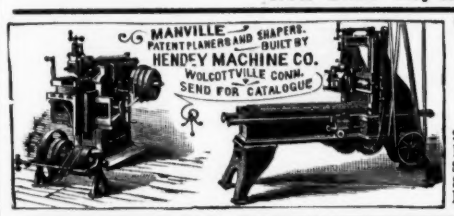

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June 15, 1882.

1 Engine Lathe, 14 in. swing x 6 ft. bed.	Ashton Hand. New.
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1 Hand " 12 in. " x 4 ft.	" Young. "
1 Back Geared Foot Lathe, 9 in. swing x 4 ft. bed, with Slide Rest and 2 Chucks, mounted on wooden bench. Second-hand. Good order.	
3 Babbitt Foot Lathes.	New.
Brigg's Foot Lathes. Nos. 1 and 2.	New.
Polishing " Small and Large.	New.
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1 Sensitive Drill.	"
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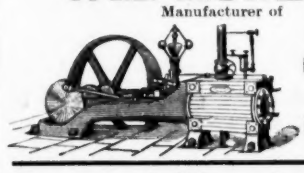

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1	42 in. Swing,	16 ft. bed.	New Engine Lathe.	June	
1	42 in. "	20 ft. "	" "	"	"
1	36 in. "	12 ft. "	" "	"	"
1	22 in. swing,	13½ ft.	Bed Engine Lathes.	June.	
3	19 in. swing,	10 ft.	Bed Engine Lathes.	"	
1	11 in. Shaper,	25 in. Traverse.	June.		

The following on hand;

2	30 in. swing,	18 ft.	Bed Engine Lathes.	New.	
1	26 in. "	16 ft.	" "	New.	
1	26 in. "	14 ft.	" "		
4	22 in. "	12 ft.	" "		
1	19 in. "	8 ft.	" "	"	
2	18 in. "	8 ft.	" "	"	
1	18 in. "	8 ft.	" "	Tilting carriage	
1	18 in. "	11 ft.	" "	"	
1	12 in. "	4 ft.	" "	New.	
1	15 in. "	9 ft.	Hand Lathe.	New.	
3	12 in. "	6 ft.	" "	"	
1	10 in. "	4½ ft.	Bed Hand Lathe.	New.	
1	26 in. x 26 in. x 6 ft.	Planer.	New.		
2	26 in. x 6 ft.	Iron Planers.	2d-hand.		
2	38 in. Swing	Upright Drills.	B. G. & S. F.	New.	
1	26 in. Drill.	B.G. & S.F.	New.		
2	20 in. Drills.				
1	18 in. Bench Drill.				
1	2 Spindle Drill.	New.			
1	4 "	"	"		
1	2 "	"	Second-Hand.		
1	3 "	"	"		
2	4 "	"	"		
2	Wall Drills, heavy.	Second-hand.	60 and 72 in		
2	12 in. Shapers.	New.			
2	15 in. "	"			
1	Pratt & Whitney Hand Miller.				
1	Sellers Milling Machine.	2d-hand.			
1	Face Milling Machine.	Second-hand.			
1	Pond's Double Milling Machine.	2d-hand.			
1	No. 2 Screw Machine.	New.	Turret Head.		
1	No. 2 "	Wire Feed.	New.		
1	No. 1 "	Brown & Sharpe.	2d-hand		
1	Screw Head Slotter.	Second-hand.			
3	Second-hand Profiling Machines				
2	4½ in Hyde's Patent Centering Machines.	New.			
1	Emery Grinder, 2d-hand.	for 10 in. Wheels.			
1	Pipe Cutting Machine.	Second Hand.	2 in.		
1	Bolt Pointing Machine.	Second-hand.			
1	Double Nut Tapper.	New Horizontal.			
1	Horizontal Boring Machine,	10 in. Swing.	2d-hand.		
1	Betts, No. 2, Power Punch.	New.			
4	Double-Acting Presses, No. 3,	nearly new.			
4	Single-Acting Presses, for power,	"			
100	Foot Presses,	nearly new.			
1	Medium Power Punching Press.	Second-hand.			
2	Small "	" Presses.	"		
1	Foot Punch, with bench.	New.			
1	Lot Pistol Machinery.	Second-hand.			
4	Grind Stones and Frames.	New.			
1	Steam Hammer.	Cylinder 6½x12.	2d-hand.		

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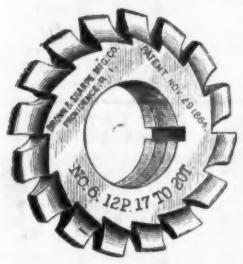

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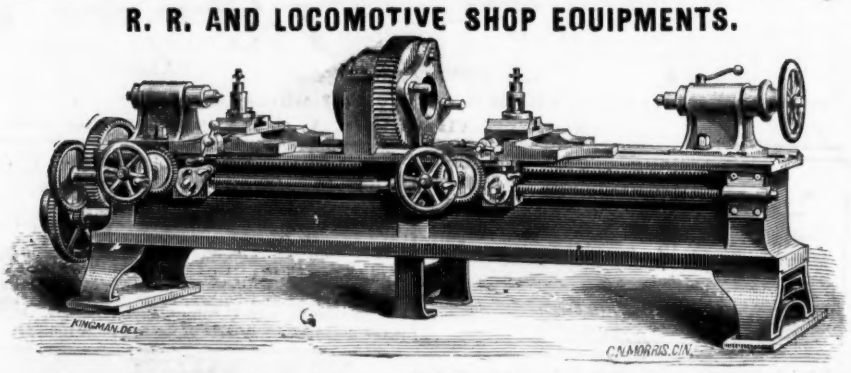

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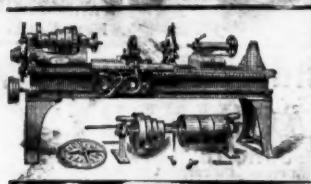

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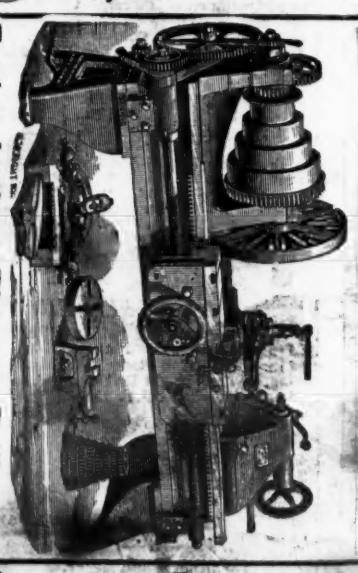

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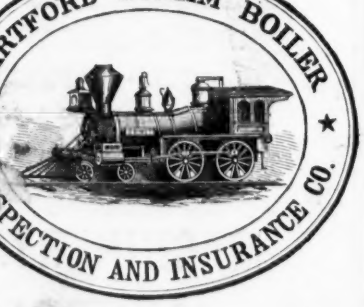

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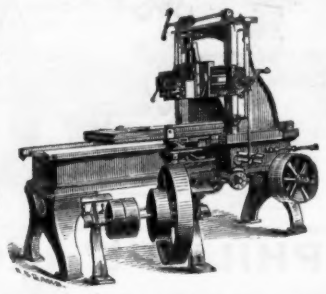

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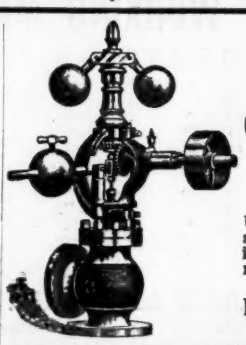

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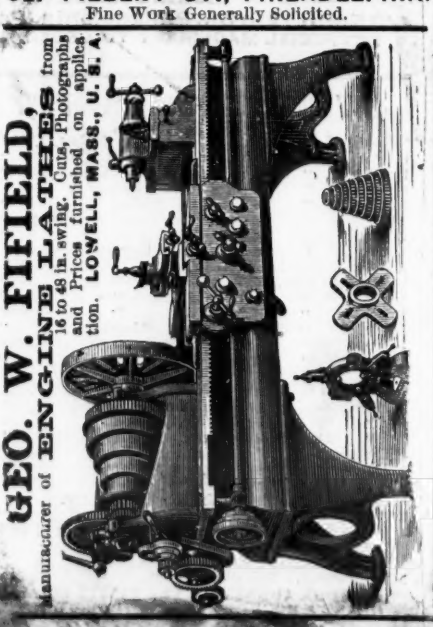
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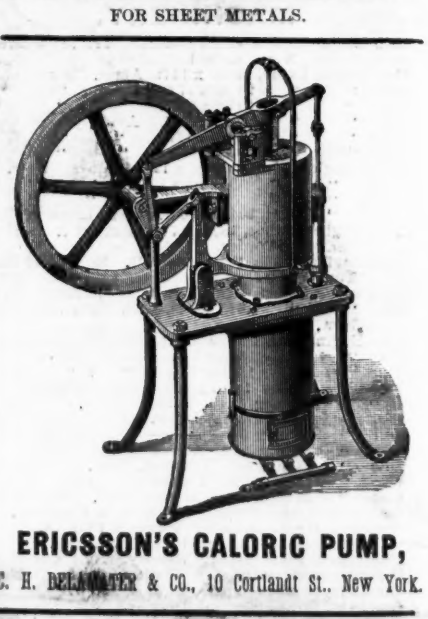

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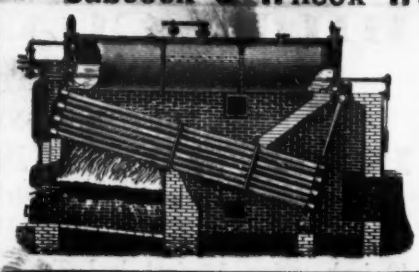

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